EXHIBIT 1

PAUL HATTAN

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EDUCATION

Iowa State University, Ames, IA
BS Mechanical Engineering; December 2003. Cumulative GPA: 3.65 / 4.0

University of Minnesota, Minneapolis, MN
MS Biomedical Engineering; 2008 Focus: Microfluidics, Medical Devices

University of St Thomas, Minneapolis, MN
Mini-Master, Medical Technology Management; 2009

WORK EXPERIENCE

University of Minnesota - Twin Cities, Department of Biomedical Engineering
Adjunct Professor. Fall 2014 - Present

- Developed and taught BMEn 4013: CAD of Biomechanical/Transport Devices, a product design course focusing on CAD modeling, design for manufacturing & assembly, and issues specific to medical device design.

University of St. Thomas, College of Engineering, St Paul, MN
Adjunct Professor. Summer 2014 - Present

- Instructed engineering courses and practical lab sections in the areas of fluid mechanics, FEA/CFD, and product design.

Paul Hattan, Minneapolis, MN
Independent Consultant. 2017 - Present

- Assisting clients with a broad range of challenges related to medical device development, product cost reduction, numerical modeling / computer simulation, regulatory / V&V testing, creation or evasion of intellectual property, and advanced engineering analysis.

Nextern, White Bear Lake, MN
Lead Mechanical Engineer. 2016-2017

- Led cost reduction initiatives for several devices in manufacturing, focusing on design improvements for increased manufacturability and assembly.
- Generated novel designs to improve intellectual property defensibility and reduce the need to license external IP.
- Provided mechanical technical leadership across engineering and manufacturing.

Devicix, LLC, Eden Prairie MN (Minneapolis)
Senior Mechanical and Biomedical Engineer. 2007-2016

Project Manager. 2011-2014

- Provided contract engineering services for medical device development to a diverse range of clients.
- Designed and executed CFD simulations and laboratory experiments to accelerate and optimize development of complex fluidic systems including non-linear valves, air-assist-atomization spray nozzles, and delivery devices for various pharmaceuticals and biologics.
- Developed custom testing systems and LabVIEW software/controls to execute product testing for engineering design support, formal design validation (DVT, V&V), and FDA approval submissions.
- Worked in an ISO-13485 and -14971 approved quality environment to help clients meet regulatory requirements and get safe, effective product(s) quickly to market.

Maytag Laundry Products, Newton IA
R&D Design Intern. Summer 2002

- Successfully designed lint and sand filtering system for Neptune TL clothes washer.
- Reduced noise emissions by 12% from Neptune primary water pump.
- Completed RCI / Kiazen Event to reduce quick dye change times.
- Designed / authored two patent disclosures.

American Airlines Maintenance and Engineering, Tulsa OK
Systems Engineer. January 2001 – August 2001

- Initiated effort to reformat MD-80 wiring manuals.
- Authored and supported new B-737 plane modifications.
- Updated and maintained airplane maintenance manuals, wiring diagrams, and part catalogues.
- Worked in diverse teams including mechanics, pilots, management, and other engineers.

CONSULTANT PROJECT EXAMPLES

- American Medical Systems had aborted internal development of a retropubic implantation system for a urinary incontinence sling due to high development costs and slow progress. I and a small Devicix team worked on-site at AMS, utilizing their quality systems, support personnel, and facilities, to resurrect the project and efficiently drive from phase 1 towards an FDA 510k approval within one year.

- Perten Instruments had a need for a high-capacity industrial liquid-cooling system for their trans-duct industrial process material analyzer. I made efficient use of CFD testing, local machine shops, and lab testing of prototypes to develop a customized cooling system of insulating barriers and liquid cooling channels that can hold the Perten instrument at 40°C while mounted to a 200°C process duct in a food-safe and dust-safe package.

- Virtual Incision, a start-up out of Lincoln, NE, needed to design a user interface for their developing implantable robotic surgery system. I employed human-factors engineering

principles to design novel hand controllers and a user-interface console that has been successfully demonstrated in multiple animal procedures with rave reviews from the operating surgeons.

- Ativa Medical contacted me to urgently assist their engineering team to prepare Ativa's microfluidic blood analysis systems (prototypes) for investor presentations. In three weeks, I solved their constant struggle with air bubble encroachment, wrote and implemented a Labview-based PID control system, and greatly improved flowrate accuracy and analysis precision.

ACADEMIC RESEARCH

University of Minnesota, Minneapolis, MN
Advisor: Prof. Victor Barocas - November 2004 – 2008
Design of microfluidic, lab-on-a-chip solutions for protein crystallization (and other ultra-precise mixing applications)

- Developed several novel microfluidic technologies including a fully scalable micropump; a non-invasive micro flowmeter; and a bench-top fabrication method for three-dimensional microfluidic channel systems
- Utilized CFD simulations to investigate the mixing and flow behaviors (diffusion and convection) of binary fluid mixtures in different shaped reaction chambers at micrometer to millimeter scales.

University of Minnesota, Minneapolis, MN
Advisor: Prof. Bin He - Summer 2004

- Direct Brain-Computer Interface (BCI): scalp EEG acquisition; computer signal filtering and processing; and visual feedback for closed-loop BCI control of computer cursor.

Iowa State University, Ames, IA.
Advisor: Prof. Sriram Sundararajan - November 2002 – June 2004

- Atomic Force Microscopy (AFM, SPM) including tapping and friction / contact modes
- Nanoscale Tribology (friction, wear) of Self-Assembling Monolayers (SAMs), L-B Films
- Active, dynamic, reversible surface modification for tribological control

COMPUTER SKILLS

- LabVIEW programming and test system automation
- Solid Modeling: SolidWorks, Pro-Engineer
- Computational Fluid Dynamics (CFD): FEMLAB/COMSOL, CFDesign, FloTHERM, SolidWorks Flow Simulation
- Finite Element Analysys (FEA): FEMLAB/COMSOL, SolidWorks COSMOS
- Statistics: Minitab, Excel

HONORS

- Medical Device Excellence Award (MDEA), Gold, 2011: Distalock System (Design Credit)

- Medical Device Excellence Award (MDEA), Silver, 2011: AcceleDent System (Design Credit)
- Institute of Technology Fellowship – U of Minnesota
- NSF Graduate Research Fellowship Program: Honorable Mention 2004
- Best Undergraduate Research Presentation – NanoExpo 2003, University of Wisconsin-Madison
- National Merit Finalist and Scholarship Recipient

PRESENTATIONS AND PUBLICATIONS (First Author or Single Author)

- "Method to determine heat transfer efficiency of a heating device and system therefor." US Patent Office US20160091373, Published March 2016
- "Low noise air circulation device." US Patent Office US20150176860, Published June 2015
- "Designing a Robotic Surgery User Interface Console." Design of Medical Devices Conference, Minneapolis, April 2012
- "SFP+ Thermal Enhancements Study." IMAPS Advanced Tech Workshop on Systems Level Packaging, Palo Alto, Nov. 2011
- "Delivery assembly, delivery tip, and method of using same." US Patent Office US20100114158, Published May 2010
- "Novel Microfluidic Technologies: Toward a Low-Cost Protien Crystallization system." Thesis Publication at University of Minnesota, Dept of Biomedical Engineering. August 2008.
- "Effect of an External Electric Field on Friction Behavior of Self-Assembled Monolayers." NanoExpo 2003, University of Wisconsin—Madison.
- "Active friction modulation of self-assembled monolayer films using external electric fields" *American Vacuum Society Symposium*, Baltimore, Nov. 2003
- "Active friction modulation of self-assembled monolayers: towards surfaces with switchable friction states." International Surface Engineering Congress, Proceedings, 2003.

OTHER INTERESTS

- Professional Event Speaker, US.Concepts (representing Guinness/Diageo)
- Foster Guardian for rescued dogs, Secondhand Hounds
- Promoting skepticism, philosophy of science, and evidence-based decision-making

EXHIBIT 2

The
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Boston · New York

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speaker. Provoke implies strong and often deliberate incitement to anger: *Her behavior was enough to provoke an angel. Aggravate* is an approximate equivalent: *"Threats only served to aggravate people in such cases"* (Thackeray). *Peeve,* somewhat informal in tone, suggests rather minor disturbance that produces a querulous, resentful response: *The flippancy of your answer peeved me. To rile* is to upset one's equanimity and stir one up: *It riled me no end to listen to such lies.*

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an·noy·ance (ə-noi′əns) *n.* **1.** The act of annoying or the state of being annoyed. **2.** A cause of irritation or vexation; a nuisance.

an·noy·ing (ə-noi′ĭng) *adj.* Causing vexation or irritation; troublesome: *an annoying cough.* —**an·noy′ing·ly** *adv.*

an·nu·al (ăn′yōō-əl) *adj. Abbr.* **ann.** **1.** Recurring, done, or performed every year; yearly: *an annual trip to Paris.* **2.** Of, relating to, or determined by a year: *an annual income.* **3.** *Botany.* Living or growing for only one year or season. —**annual** *n.* **1.** A periodical published yearly; a yearbook. **2.** *Botany.* A plant that completes its entire life cycle in a single growing season. [Middle English *annuel,* from Old French, from Late Latin *annuālis,* ultimately from Latin *annus,* year. See **at-** in Appendix.] —**an′nu·al·ly** *adv.*

an·nu·al·ize (ăn′yōō-ə-līz′) *tr.v.* **-ized, -iz·ing, -iz·es.** To adjust or calculate so as to reflect a rate that is based on a full year: *Brokers annualize a yield on an investment by multiplying weekly dividends by 52 and dividing the answer by the net asset value per share.*

annual ring *n. Botany.* The layer of wood formed in a plant during a single year. Annual rings appear concentric when viewed in cross section.

an·nu·i·tant (ə-nōō′ĭ-tənt, ə-nyōō′-) *n.* **1.** One that receives or is qualified to receive an annuity. **2.** An officially retired U.S. intelligence officer who is actually still on the government's payroll and is available for assignments.

an·nu·i·ty (ə-nōō′ĭ-tē, ə-nyōō′-) *n., pl.* **-ties.** *Abbr.* **ann.** **1.a.** The annual payment of an allowance or income. **b.** The right to receive this payment or the obligation to make this payment. **2.** An investment on which one receives fixed payments for a lifetime or for a specified number of years. [Middle English *annuite,* from Anglo-Norman, from Medieval Latin *annuitās,* from Latin *annus,* yearly, from *annus,* year. See **at-** in Appendix.]

an·nul (ə-nŭl′) *tr.v.* **-nulled, -nul·ling, -nuls.** **1.** To make or declare void or invalid, as a marriage or a law; nullify. **2.** To obliterate the effect or existence of: *"The significance of the past . . . is annulled in idle gusts of electronic massacre"* (Alexander Cockburn). [Middle English *annullen,* from Old French *annuller,* from Late Latin *annullāre* : Latin *ad-,* ad- + Latin *nullus,* none; see **ne** in Appendix.]

an·nu·lar (ăn′yə-lər) *adj.* Shaped like or forming a ring. [Latin *ānulāris,* from *ānulus,* ring. See ANNULUS.]

annular eclipse *n.* A solar eclipse in which the moon covers all but a bright ring around the circumference of the sun.

annular ligament *n.* The fibrous band of tissue that surrounds the ankle joint or the wrist joint.

an·nu·late (ăn′yə-lĭt, -lāt′) also **an·nu·lat·ed** (-lā′tĭd) *adj.* Having or consisting of rings or ringlike segments. [Latin *ānulātus,* from *ānulus,* ring. See ANNULUS.]

an·nu·la·tion (ăn′yə-lā′shən) *n.* **1.** The act or process of forming rings. **2.** A ringlike structure, segment, or part.

an·nu·let (ăn′yə-lĭt) *n. Architecture.* A ringlike molding around the capital of a pillar. [Latin *ānulus,* ring; see ANNULUS + -ET.]

an·nu·li (ăn′yə-lī′) *n.* A plural of **annulus.**

an·nul·ment (ə-nŭl′mənt) *n.* **1.** An act of making or declaring void. **2.** The retrospective as well as prospective invalidation of a marriage, as for nonconsummation, effected by means of a declaration stating that the marriage was never valid.

an·nu·lus (ăn′yə-ləs) *n., pl.* **-lus·es** or **-li** (-lī′). **1.** A ringlike figure, part, structure, or marking, such as a growth ring on the scale of a fish. **2.a.** A ring or group of thick-walled cells around the sporangia of many ferns that functions in spore release. **b.** The ringlike remains of a broken partial veil, found around the stipes of certain mushrooms. **3.** *Mathematics.* The figure bounded by and containing the area between two concentric circles. [Latin *ānulus,* ring, diminutive of *ānus.*]

an·nun·ci·ate (ə-nŭn′sē-āt′) *tr.v.* **-at·ed, -at·ing, -ates.** To announce; proclaim: *"They do not so properly affirm, as annunciate it"* (Charles Lamb). [Latin *annūntiāre, annūntiāt-.* See ANNOUNCE.]

an·nun·ci·a·tion (ə-nŭn′sē-ā′shən) *n.* **1.** The act of announcing. **2.** An announcement; a proclamation. **3. Annunciation.** **a.** The angel Gabriel's announcement to the Virgin Mary of the Incarnation. **b.** The Christian feast celebrating this event. **c.** March 25, the day on which this feast is observed.

an·nun·ci·a·tor (ə-nŭn′sē-ā′tər) *n.* One that announces, especially an electrical signaling device used in hotels or offices to indicate the sources of calls on a switchboard.

an·nus mi·rab·i·lis (ăn′əs mĭ-răb′ə-lĭs) *n., pl.* **an·ni mi·ra·bi·les** (ăn′ī mĭ-răb′ə-lēz, ăn′ē). A year notable for disasters or wonders; a fateful year: *"Hungary's blood bath was the saddest event in that annus mirabilis"* (C.L. Sulzberger). [New Latin : Latin *annus,* year + Latin *mīrābilis,* wondrous.]

a·no·a (ə-nō′ə) *n.* A small buffalo *(Bubalus* or *Anoa depressicornis)* of Celebes and the Philippines, having short, pointed horns. [Native word in Celebes.]

an·ode (ăn′ōd′) *n. Abbr.* **a.** **1.** A positively charged electrode, as of an electrolytic cell, a storage battery, or an electron tube. **2.** The negatively charged terminal of a primary cell or of a storage battery that is supplying current. [Greek *anodos,* a way up ; *ana-,* ana- + *hodos,* way.]

an·o·dize (ăn′ə-dīz′) *tr.v.* **-dized, -diz·ing, -diz·es.** To coat (a metallic surface) electrolytically with a protective or decorative oxide. [ANOD(E) + -IZE.] —**an′o·di·za′tion** (-dĭ-zā′shən) *n.*

an·o·dyne (ăn′ə-dīn′) *adj.* **1.** Capable of soothing or eliminating pain. **2.** Relaxing: *anodyne novels about country life.* **3.** Watered-down; insipid: *"At the time, I thought that passage was pretty anodyne"* (Conor Cruise O'Brien). —**anodyne** *n.* **1.** A medicine, such as aspirin, that relieves pain. **2.** A source of soothing comfort. [Latin *anōdynus,* from Greek *anōdunos,* free from pain : *an-,* without; see A-[1] + *odunē,* pain; see **ed-** in Appendix.]

a·noint (ə-noint′) *tr.v.* **a·noint·ed, a·noint·ing, a·noints.** **1.** To apply oil, ointment, or a similar substance to. **2.** To put oil on during a religious ceremony as a sign of sanctification or consecration. **3.** To choose by or as if by divine intervention. [Middle English *enointen,* from Old French *enoint,* past participle of *enoindre,* from Latin *inunguere, inūnct-* ; *in-,* on; see IN-[2] + *unguere,* to smear.] —**a·noint′ment** *n.*

a·noint·ing of the sick (ə-noin′tĭng) *n. Roman Catholic Church.* The sacrament of anointing a critically ill or weak person, with prayers for recovery and an act of penance or confession.

a·no·le (ə-nō′lē) *n.* Any of various chiefly tropical New World lizards of the genus *Anolis,* characterized by a distensible throat flap and the ability to change color. Also called *chameleon.* [French *anolis,* of Cariban origin.]

a·nom·a·lous (ə-nŏm′ə-ləs) *adj.* **1.** Deviating from the normal or common order, form, or rule. **2.** Equivocal, as in classification or nature. [From Late Latin *anōmalos,* from Greek, uneven : probably from *an-,* not; see A-[1] + *homalos,* even (from *homos,* same; see **sem-**[1] in Appendix).]

a·nom·a·ly (ə-nŏm′ə-lē) *n., pl.* **-lies.** **1.** Deviation or departure from the normal or common order, form, or rule: *"NASA's system for tracking anomalies for flight readiness reviews failed"* (Presidential Commission Report on the Challenger Disaster). **2.** One that is peculiar, irregular, abnormal, or difficult to classify: *"Both men are anomalies: they have . . . likable personalities but each has made his reputation as a heavy"* (David Pauly). **3.** *Astronomy.* The angular deviation, as observed from the sun, of a planet from its perihelion. —**a·nom′a·lis′tic** (-lĭs′tĭk), **a·nom′a·lis′ti·cal** *adj.* —**a·nom′a·lis′ti·cal·ly** *adv.*

an·o·mic (ə-nŏm′ĭk, ə-nō′mĭk) *adj.* Socially unstable, alienated, and disorganized: *"anomic loners musing over their fate"* (Francine du Plessix Gray). —**anomic** *n.* A socially unstable, alienated person: *"The picture* [is] *about two anomics who inch their way to spiritual rebirth"* (Pauline Kael).

an·o·mie or **an·o·my** (ăn′ə-mē) *n.* **1.** Social instability caused by steady erosion of standards and values. **2.** Alienation and purposelessness experienced by a person or a class as a result of a lack of standards and values. **3.** Personal disorganization resulting in unsocial behavior. [French, from Greek *anomia,* lawlessness, from *anomos,* lawless : *a-,* without; see A-[1] + *nomos,* law; see **nem-** in Appendix.]

a·non (ə-nŏn′) *adv.* **1.** At another time; later. **2.** In a short time; soon. **3.** *Archaic.* At once; forthwith. —***idiom.* ever (or now) and anon.** Time after time; now and then. [Middle English, at once, from Old English *on ān* : *on,* in; see ON + *ān,* one; see **oi-no-** in Appendix.]

anon. *abbr.* Anonymous.

an·o·nym (ăn′ə-nĭm′) *n.* **1.** An anonymous person. **2.** A pseudonym. [French *anonyme,* from Late Latin *anōnymus,* anonymous. See ANONYMOUS.]

an·o·nym·i·ty (ăn′ə-nĭm′ĭ-tē) *n., pl.* **-ties.** **1.** The quality or state of being unknown or unacknowledged. **2.** One that is unknown or unacknowledged.

a·non·y·mous (ə-nŏn′ə-məs) *adj. Abbr.* **anon., a.** **1.** Having an unknown or unacknowledged name: *an anonymous author.* **2.** Having an unknown or withheld authorship or agency: *an anonymous letter; an anonymous phone call.* **3.** Having no distinctive character or recognition factor: *"a very great, almost anonymous center of people who just want peace"* (Alan Paton). [From Late Latin *anōnymus,* from Greek *anōnumos,* nameless : *an-,* without; see A-[1] + *onuma,* name; see **nō-men-** in Appendix.]

a·noph·e·les (ə-nŏf′ə-lēz′) *n.* Any of various mosquitoes of the genus *Anopheles,* which can carry the malaria parasite and transmit the disease to human beings. [From Greek *anōphelēs,* useless : *an-,* without; see A-[1] + *ophelos,* advantage.] —**a·noph′e·line′** (-līn′, -lĭn) *adj.*

an·o·rak (ăn′ə-răk′) *n.* A heavy jacket with a hood; a parka. [Greenlandic Eskimo *annoraaq,* formerly spelled *ánorâk.*]

an·o·rec·tic (ăn′ə-rĕk′tĭk) also **an·o·ret·ic** (-rĕt′ĭk) —*adj.* **1.** Marked by loss of appetite. **2.** Suppressing or causing loss of appetite. **3.** Of or affected with anorexia nervosa. —*n.* **1.** One who is affected with anorexia nervosa. **2.** An anorectic drug.

Annunciation
Early 16th-century painting, *The Annunciation,* by Juan de Flandes

anorak

less crystalline compound, $C_{15}H_{23}NO_4$, that is used as an agricultural fungicide.

cy·cloid (sī′kloid′) *adj.* **1.** Resembling a circle. **2.** *Zoology.* a. Flat, rounded, and smooth-edged; disklike. Used of fish scales. b. Having or composed of such scales. **3.** *Psychiatry.* Afflicted with or relating to cyclothymia. —**cycloid** *n.* **1.** *Mathematics.* The curve traced by a point on the circumference of a circle that rolls on a straight line. **2.** *Zoology.* A fish having cycloid scales. [French *cycloïde*, from Greek *kukloeidēs*, circular : *kuklos*, circle; see **k"el-**[1] in Appendix + *-oeidēs*, -oid.] —**cy·cloi′dal** (-kloid′l) *adj.*

cy·clom·e·ter (sī-klŏm′ĭ-tər) *n.* **1.** An instrument that records the revolutions of a wheel to indicate distance traveled. **2.** An instrument that measures circular arcs. —**cy′clo·met′ric** (-klə-mĕt′rĭk) *adj.* —**cy·clom′e·try** *n.*

cy·clone (sī′klōn′) *n.* **1.** *Meteorology.* An atmospheric system characterized by the rapid, inward circulation of air masses about a low-pressure center, usually accompanied by stormy, often destructive, weather. Cyclones circulate counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. **2.** A violent, rotating windstorm. **3.** Any of various devices using centrifugal force to separate materials. [From Greek *kuklōn*, present participle of *kukloun*, to rotate, from *kuklos*, circle. See **k"el-**[1] in Appendix.] —**cy·clon′ic** (-klŏn′ĭk), **cy·clon′i·cal** *adj.*

cyclone cellar *n.* An underground shelter in or adjacent to a house, used for protection from severe windstorms. Also called storm cellar.

cy·clo·pae·di·a (sī′klə-pē′dē-ə) *n.* Variant of **cyclopedia.**

cy·clo·par·af·fin (sī′klō-păr′ə-fĭn) *n.* See **cycloalkane.**

cy·clo·pe·an (sī′klə-pē′ən, sī-klō′pē-) *adj.* **1.** Often **Cyclopean.** Relating to or suggestive of a Cyclops: *a great Cyclopean monocle.* **2.** Of or constituting a primitive style of masonry characterized by the use of massive stones of irregular shape and size.

cy·clo·pe·di·a also **cy·clo·pae·di·a** (sī′klə-pē′dē-ə) *n.* An encyclopedia. [Short for ENCYCLOPEDIA.] —**cy′clo·pe′dic** (-dĭk) *adj.* —**cy′clo·pe′dist** (-dĭst) *n.*

cy·clo·pen·tane (sī′klə-pĕn′tān′, sī′klə-) *n.* A colorless, flammable, liquid cycloalkane, C_5H_{10}, derived from petroleum and used as a solvent and motor fuel.

Cy·clo·pes (sī-klō′pēz) *n. Greek Mythology.* Plural of **Cyclops.**

cy·clo·phos·pha·mide (sī′klə-fŏs′fə-mīd′) *n.* A highly toxic, immunosuppressive, antineoplastic drug, $C_7H_{15}Cl_2N_2P$, used in the treatment of Hodgkin's disease, lymphoma, and certain leukemias.

cy·clo·ple·gia (sī′klə-plē′jə) *n.* Paralysis of the ciliary muscles of the eye, resulting in the loss of visual accomodation.

cy·clo·pro·pane (sī′klə-prō′pān′) *n.* A highly flammable, explosive, colorless gas, C_3H_6, sometimes used as an anesthetic.

Cy·clops (sī′klŏps) *n., pl.* **Cy·clo·pes** (sī-klō′pēz). *Greek Mythology.* **1.** Any of the three one-eyed Titans who forged thunderbolts for Zeus. **2.** Any of a race of one-eyed giants, reputedly descended from these Titans, inhabiting the island of Sicily. [Latin, from Greek *Kuklōps* : *kuklos*, circle; see CYCLE + *ōps*, eye; see MYOPIA.]

cy·clo·ram·a (sī′klə-răm′ə, -rä′mə) *n.* **1.** A large composite picture placed on the interior walls of a cylindrical room so as to appear in natural perspective to a spectator standing in the center of the room. **2.** A large curtain or wall, usually concave, hung or placed at the rear of a stage. [CYCL(O)– + (PAN)ORAMA.] —**cy′clo·ram′ic** *adj.*

cy·clo·ser·ine (sī′klō-sĕr′ēn) *n.* An antibiotic effective against a wide range of bacteria, used especially in the treatment of tuberculosis and infections of the urinary tract.

cy·clo·sis (sī-klō′sĭs) *n., pl.* **-ses** (-sēz). The streaming rotary motion of protoplasm within certain cells and one-celled organisms. [New Latin, from Greek *kuklōsis*, a surrounding, from *kuklounein*, to surround, from *kuklos*, circle. See **k"el-**[1] in Appendix.]

cy·clo·spor·ine (sī′klə-spôr′ēn, -ĭn, -spōr′-) also **cy·clo·spor·in** (-ĭn) *n.* An immunosuppressive drug obtained from certain soil fungi, used mainly to prevent the rejection of transplanted organs.

cy·clo·stome (sī′klə-stōm′) *n.* Any of various primitive eellike vertebrates of the class Agnatha, such as a lamprey, lacking jaws and true teeth and having a circular, sucking mouth. [From New Latin *Cyclostomī* and *Cyclostomata*, class names : CYCLO– + Greek *stoma*, *stomat-*, mouth.] —**cy·clos′to·mate′** (sī-klŏs′tə-māt′, -mĭt), **cy′clo·stom′a·tous** (sī′klə-stŏm′ə-təs, -stō′mə-) *adj.*

cy·clo·thyme (sī′klə-thīm′) *n.* A person afflicted with cyclothymia.

cy·clo·thy·mi·a (sī′klə-thī′mē-ə) *n. Psychiatry.* A mild affective disorder characterized by alternating periods of elation and depression. —**cy′clo·thy′mic** (-mĭk) *adj. & n.*

cy·clo·tron (sī′klə-trŏn′) *n.* A circular particle accelerator in which charged subatomic particles generated at a central source are accelerated spirally outward in a plane perpendicular to a fixed magnetic field by an alternating electric field. A cyclotron is capable of generating particle energies between a few million and several tens of millions of electron volts.

cy·der (sī′dər) *n. Chiefly British.* Variant of **cider.**

cyg·net (sĭg′nĭt) *n.* A young swan. [Middle English *cignet*, from Anglo-Norman, diminutive of Old French *cygne*, swan, from Latin *cygnus*, from Greek *kuknos*.]

Cyg·nus (sĭg′nəs) *n.* A constellation in the Northern Hemisphere near Lacerta and Lyra, containing the star Deneb. Also called *Northern Cross, Swan.* [Latin *cygnus*, swan. See CYGNET.]

cyl·in·der (sĭl′ən-dər) *n.* Abbr. **cyl.** **1.** *Mathematics.* **a.** The surface generated by a straight line intersecting and moving along a closed plane curve, the directrix, while remaining parallel to a fixed straight line that is not on or parallel to the plane of the directrix. **b.** The portion of such a surface bounded by two parallel planes and the regions of the planes bounded by the surface. **c.** A solid bounded by two parallel planes and such a surface, especially such a surface having a circle as its directrix. **2.** A cylindrical container or object. **3.** *Engineering.* **a.** The chamber in which a piston of a reciprocating engine moves. **b.** The chamber of a pump from which fluid is expelled by a piston. **4.** The rotating chamber of a revolver that holds the cartridges. **5.** Any of several rotating parts in a printing press, especially one that carries the paper. **6.** *Archaeology.* A cylindrical stone or clay object with an engraved design or inscription. [Latin *cylindrus*, from Greek *kulindros*, from *kulindein*, to roll.]

cylinder head *n.* The closed, often detachable, end of a cylinder in an internal-combustion engine.

cy·lin·dri·cal (sə-lĭn′drĭ-kəl) also **cy·lin·dric** (-drĭk) *adj.* **1.** Of, relating to, or having the shape of a cylinder, especially of a circular cylinder. **2.** *Mathematics.* Of or relating to the coordinate system, or to any of three coordinates in it, formed by two polar coordinates in a plane and a rectangular coordinate measured perpendicularly from the plane. —**cy·lin′dri·cal′i·ty** (-kăl′ĭ-tē) *n.* —**cy·lin′dri·cal·ly** *adv.*

cyl·in·droid (sĭl′ən-droid′) *n. Mathematics.* A cylindrical surface or solid all of whose sections perpendicular to the elements are elliptical. —**cylindroid** *adj.* Resembling a cylinder.

cy·ma (sī′mə) *n. Architecture.* A molding for a cornice, having a partly concave and partly convex curve in profile, used especially in classical architecture. Also called *cymatium.* [Greek *kuma*, wave, cyma, from *kuein*, to swell. See **keue-** in Appendix.]

cy·ma·tium (sī-mā′shəm, -shē-əm) *n., pl.* **-tia** (-shə, -shē-ə). *Architecture.* **1.** See **cyma. 2.** The topmost molding of a classical cornice. [Latin, from Greek *kumation*, diminutive of *kuma*, cyma. See CYMA.]

cym·bal (sĭm′bəl) *n. Music.* A percussion instrument consisting of a concave brass plate that makes a loud clashing tone when hit with a drumstick or when used in pairs. [Middle English, from Old English and from Old French *cymbale*, both from Latin *cymbalum*, from Greek *kumbalon*, from *kumbē*, bowl.] —**cym′bal·eer′** (sĭm′bə-lîr′), **cym′bal·er**, **cym′bal·ist** *n.*

cym·bid·i·um (sĭm-bĭd′ē-əm) *n.* Any of various epiphytic orchids of the genus *Cymbidium*, native to tropical Asia and Australia and extensively hybridized and cultivated for their elongate clusters of showy blooms. [New Latin *Cymbidium*, genus name, from Latin *cymba*, boat, from Greek *kumbē*.]

cyme (sīm) *n. Botany.* A usually flat-topped or convex flower cluster in which the main axis and each branch end in a flower that opens before the flowers below or to the side of it. [Latin *cȳma*, young cabbage sprout, from Greek *kuma*. See CYMA.] —**cy·mif′er·ous** (sī-mĭf′ər-əs) *adj.*

cy·mene (sī′mēn′) *n.* Any of three colorless isomeric liquid hydrocarbons, $C_{10}H_{14}$, obtained chiefly from the essential oils of cumin and thyme and used in the manufacture of synthetic resins. [French *cymène*, from *kuminon*, cumin, probably of Semitic origin.]

cym·ling (sĭm′lĭng) also **cym·lin** (-lĭn) *n.* A greenish-white, flat, round squash with a scalloped edge. [Alteration of SIMNEL.]

cy·mo·gene (sī′mə-jēn′) *n.* A flammable gaseous fraction of petroleum, consisting chiefly of butane. [CYM(ENE) + –GENE.]

cy·moid (sī′moid′) *adj.* **1.** *Architecture.* Resembling a cyma. **2.** *Botany.* Resembling a cyme.

cy·mo·phane (sī′mə-fān′) *n.* A variety of chrysoberyl having a shimmering luster and microscopic, needlelike inclusions that reflect a streak of light. [French : Greek *kuma*, wave, cyma; see CYMA + Greek *-phanēs*, appearing; see –PHANE.]

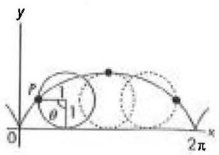
cy·mose (sī′mōs′) also **cy·mous** (-məs) *adj.* **1.** Relating to or resembling a cyme; determinate. **2.** Bearing a cyme or cymes. [CYM(E) + –OSE[1].] —**cy′mose′ly** *adv.*

Cym·ric (kĭm′rĭk, sĭm′-) *adj.* Of or relating to the Cymry. —**Cymric** *n.* See **Welsh** (sense 2).

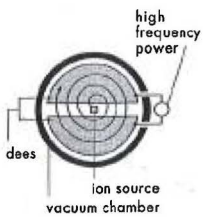
Cym·ry (kĭm′rē, sĭm′-) *n. (used with a pl. verb).* **1.** The Brythonic Celts of Wales, Cornwall, and Brittany. **2.** The Welsh. [Welsh, pl. of *Cymro*, the Welsh people, Wales, from British Celtic **kombrogos*, fellow countryman. See **merg-** in Appendix.]

Cyn·e·wulf (kĭn′ə-wo͝olf′) or **Cyn·wulf** (kĭn′wo͝olf′). fl. c. 900. Anglo-Saxon poet whose extant works are *Juliana, Elene, The Ascension,* and *The Fates of the Apostles.*

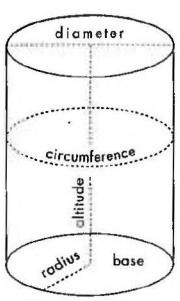
cyn·ic (sĭn′ĭk) *n.* **1.** A person who believes all people are motivated by selfishness. **2. Cynic.** A member of a sect of ancient Greek philosophers who believed virtue to be the only good and self-control to be the only means of achieving virtue. —**cynic** *adj.* **1.** Cynical. **2. Cynic.** Of or relating to the Cynics or their beliefs. [Latin *cynicus*, Cynic philosopher, from Greek *kunikos*, from *kuōn, kun-*, dog. See **kwon-** in Appendix.]



cycloid
Coordinates of *P*:
$x = \phi - \sin\phi$
$y = 1 - \cos\phi$



cyclotron



cylinder


cymbal
Pair of cymbals

ular or spherical form toward elliptic or ellipsoidal form. **2.** The degree of this deviation.

El·lis (ĕl′ĭs), **Alexander John.** 1814–1890. British philologist and mathematician noted for his scientific study of phonetics.

Ellis, (Henry) Havelock. 1859–1939. British psychologist and writer known for his pioneering works on sexuality, such as *Studies in the Psychology of Sex* (seven volumes, 1897–1928).

Ellis Island. An island of Upper New York Bay southwest of Manhattan. It was the chief immigration station of the United States from 1892 to 1943.

El·li·son (ĕl′ĭ-sən), **Ralph Waldo.** 1914–1994. American writer whose novel *Invisible Man* (1952) is a naturalistic depiction of a young black man's struggle against American society.

Ells·worth (ĕlz′wûrth′), **Lincoln.** 1880–1951. American explorer who took part in several polar expeditions, including a 1935 flight across the Antarctic.

Ellsworth, Oliver. 1745–1807. American jurist and politician. A U.S. senator from Connecticut (1789–1796), he worked on the legislation that created the federal court system (1789) and later served as the chief justice of the U.S. Supreme Court (1796–1800).

Ellsworth Land. A high plateau of western Antarctica south of the Antarctic Peninsula. It includes the **Ellsworth Mountains,** rising to 5,142.3 m (16,860 ft) at Vinson Massif.

elm (ĕlm) *n.* **1.** Any of various deciduous trees of the genus *Ulmus,* characteristically having arching or curving branches and serrate leaves with asymmetrical bases. Elms are widely planted as shade trees. **2.** The wood of one of these trees. [Middle English, from Old English.]

El·man (ĕl′mən), **Mischa.** 1891–1967. Russian-born American violinist regarded as one of the foremost violinists of his time.

El Man·sū·ra (măn-sōōr′ə). A city of northern Egypt on a branch of the Nile River. It is a commercial and industrial center. Population, 328,700.

elm bark beetle *n.* Either of two bark beetles *(Scolytus multistriatus* or *Hylurgopinus rufipes)* that transmit the fungus causing Dutch elm disease.

Elm·hurst (ĕlm′hûrst′). A city of northeast Illinois, a residential and industrial suburb of Chicago. Population, 44,276.

El·mi·ra (ĕl-mī′rə). A city of southern New York near the Pennsylvania border west of Binghamton. Mark Twain is buried here. Population, 35,327.

El Mis·ti (mēs′tē). A dormant volcano, 5,825.8 m (19,101 ft) high, in the Cordillera Occidental of southern Peru. It has long figured in Peruvian legends and poetry.

El Mon·te (mŏn′tē). A city of southern California east of Los Angeles. It is an industrial center in an area noted for its walnut groves. Population, 79,494.

Elm·wood Park (ĕlm′wŏŏd′). **1.** A village of northeast Illinois, a residential suburb of Chicago. Population, 24,016. **2.** A borough of northeast New Jersey southeast of Paterson. It was originally called East Paterson. Population, 18,377.

El Ni·ño (nēn′yō) *n. Oceanography.* A warming of the ocean surface off the western coast of South America that occurs every 4 to 12 years when upwelling of cold, nutrient-rich water does not occur. It causes plankton and fish to die and affects weather over much of the Pacific Ocean. [American Spanish, from Spanish, the Christ child (from the association between the onset of the warming and Christmastide) : *el,* the (from Latin *ille;* see **al-**[1] in Appendix) + *niño,* child (from Old Spanish *ninno,* from Vulgar Latin **nunnus*).]

El O·beid (ō-bād′). See **Al Ubayyid.**

el·o·cu·tion (ĕl′ə-kyōō′shən) *n.* **1.** The art of public speaking in which gesture, vocal production, and delivery are emphasized. **2.** A style or manner of speaking, especially in public. [Middle English *elocucion,* from Latin *ēlocūtiō, ēlocūtiōn-,* from *ēlocūtus,* past participle of *ēloquī,* to speak out : *ē-, ex-,* ex- + *loquī,* to speak; see **tolkʷ-** in Appendix.] **—el′o·cu′tion·ar′y** (-shə-nĕr′ē) *adj.* **—el′o·cu′tion·ist** *n.*

e·lo·dea (ĭ-lō′dē-ə) *n.* Any of various small, submersed herbs of the genus *Elodea,* having grasslike leaves. [New Latin *Elodea,* genus name, from Greek *helōdēs,* marshy, from *helos,* marsh.]

e·loign (ĭ-loin′) *tr.v.* **e·loigned, e·loign·ing, e·loigns.** *Archaic.* **1.** To remove or carry away to a distance, especially so as to conceal. **2.** To take (oneself) to a distance. [Middle English *esloigner* : *es-,* from (from Latin *ex-;* see **ex-**[1] in Appendix) + *loing,* far (from Latin *longē,* distant, from *longus,* long; see **del-**[1] in Appendix).]

e·lon·gate (ĭ-lông′gāt′, ĭ-lŏng′-) *tr. & intr.v.* **-gat·ed, -gat·ing, -gates.** To make or grow longer. **—elongate** or **elongated** *adj.* **1.** Made longer; extended. **2.** Having more length than width; slender. [Late Latin *ēlongāre, ēlongāt-* : Latin *ē-, ex-,* ex- + Latin *longē,* distant; see **ELOIGN.**]

e·lon·ga·tion (ĭ-lông′-gā′shən, ĭ-lŏng′-, ē′lông-, ē′lŏng-) *n.* **1.** The act of elongating or the condition of being elongated. **2.** Something that elongates; an extension. **3.** The angular distance between two celestial bodies as seen from Earth.

e·lope (ĭ-lōp′) *intr.v.* **e·loped, e·lop·ing, e·lopes.** **1.** To run away with a lover, especially with the intention of getting married. **2.** To run away; abscond. [Perhaps Anglo-Norman *aloper,* to run away from one's husband with a lover, from Middle Dutch *ontlopen,* to run away : *ont-,* away from, along; see **ant-** in Appendix + *lopen,* to run.] **—e·lope′ment** *n.* **—e·lop′er** *n.*

el·o·quence (ĕl′ə-kwəns) *n.* **1.a.** Persuasive, powerful discourse. **b.** The skill or power of using such discourse. **2.** The quality of persuasive, powerful expression.

el·o·quent (ĕl′ə-kwənt) *adj.* **1.** Characterized by persuasive, powerful discourse: *an eloquent speaker; an eloquent sermon.* **2.** Vividly or movingly expressive: *a look eloquent with compassion.* See Synonyms at **expressive.** [Middle English, from Old French, from Latin *ēloquēns, ēloquent-,* present participle of *ēloquī,* to speak out. See **ELOCUTION.**] **—el′o·quent·ly** *adv.* **—el′o·quent·ness** *n.*

El Pas·o (păs′ō). A city of extreme western Texas on the Rio Grande opposite Ciudad Juárez, Mexico. The surrounding area was first settled by Spanish missionaries, soldiers, and traders in the 17th century. Population, 425,259.

El Sal·va·dor (săl′və-dôr′, säl′vä-*th*ôr′). A country of Central America bordering on the Pacific Ocean. Discovered in 1523, the region became independent from Spain in 1821. San Salvador is the capital and the largest city. Population, 4,949,000. **—El Sal′va·dor′i·an** (săl′və-dôr′ē-ən, -dōr′-) *adj. & n.*

else (ĕls) *adj.* **1.** Other; different: *Ask somebody else.* **2.** Additional; more: *Would you like anything else?* **—else** *adv.* **1.** In a different or an additional time, place, or manner: *I have always done it this way and I do not know how else it could be done. Where else would you like to go besides San Francisco?* **2.** If not; otherwise: *Be careful, or else you will make a mistake.* **—idiom. or else.** Regardless of any extenuating circumstances: *Be there on time or else!* [Middle English *elles,* from Old English. See **al-**[1] in Appendix.]

USAGE NOTE: *Else* is often used redundantly in combination with prepositions such as *but, except,* and *besides: No one else but Sam saw the accident* (omit *else*). • When a pronoun is followed by *else,* the possessive form is generally written thus: *someone else's* (not *someone's else*). Both *who else's* and *whose else* are in use, but not *whose else's: Who else's book could it have been? Whose else could it have been?* See Usage Notes at **who, whose.**

else·where (ĕls′hwâr′, -wâr′) *adv.* In or to a different or another place: *has property at the shore and elsewhere.*

El·si·nore (ĕl′sə-nôr′, -nōr′). See **Helsingør.**

ELSS *abbr. Aerospace.* Extravehicular life support system.

El To·ro (tôr′ō). A community of southern California southeast of Santa Ana. It is mainly residential. Population, 38,153.

el·u·ant (ĕl′yōō-ənt) *n.* A substance used as a solvent in the process of elution. [From Latin *ēluēns, ēluent-,* present participle of *ēluere,* to wash out. See **ELUTE.**]

el·u·ate (ĕl′yōō-ĭt, -āt′) *n.* The solution of solvent and dissolved matter resulting from elution. [Latin *ēluere,* to wash out; see **ELUTE** + **-ATE**[1].]

e·lu·ci·date (ĭ-lōō′sĭ-dāt′) *v.* **-dat·ed, -dat·ing, -dates.** *—tr.* To make clear or plain, especially by explanation; clarify. *—intr.* To give an explanation that serves to clarify. See Synonyms at **explain.** [Late Latin *ēlūcidāre, ēlūcidāt-* : *ē-, ex-,* intensive pref.; see **EX-** + Latin *lūcidus,* bright (from *lūcēre,* to shine; see **leuk-** in Appendix).] **—e·lu′ci·da′tion** *n.* **—e·lu′ci·da′tive** *adj.* **—e·lu′ci·da′tor** *n.*

e·lude (ĭ-lōōd′) *tr.v.* **e·lud·ed, e·lud·ing, e·ludes.** **1.** To evade or escape from, as by daring, cleverness, or skill: *The suspect continues to elude the police.* **2.** To escape the understanding or grasp of: *a metaphor that eluded them.* See Synonyms at **escape.** [Latin *ēlūdere* : *ē-, ex-,* ex- + *lūdere,* to play (from *lūdus,* play; see **leid-** in Appendix).]

E·lul (ĕl′ōōl, ĕ-lōōl′) *n.* The 12th month of the year in the Jewish calendar. See table at **calendar.** [Hebrew *'Elūl,* from Akkadian *ulūlu, elūlu,* the month Ululu (August/September).]

e·lu·sive (ĭ-lōō′sĭv, -zĭv) *adj.* **1.** Tending to elude capture, perception, comprehension, or memory: *"an invisible cabal of conspirators, each more elusive than the archterrorist* [himself]*"* (David Kline). **2.** Difficult to define or describe: *"Failures are more finely etched in our minds than triumphs, and success is an elusive, if not mythic, goal in our demanding society"* (Hugh Drummond). [From Latin *ēlūsus,* past participle of *ēlūdere,* to elude. See **ELUDE.**] **—e·lu′sive·ly** *adv.* **—e·lu′sive·ness** *n.*

e·lute (ĭ-lōōt′) *tr.v.* **e·lut·ed, e·lut·ing, e·lutes.** To extract (one material) from another, usually by means of a solvent. [From Latin *ēluere, ēlūt-,* to wash out : *ē-, ex-,* ex- + *lavere,* to wash; see **leu(ə)-** in Appendix.] **—e·lu′tion** *n.*

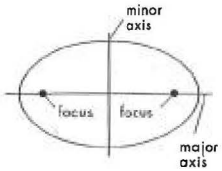
e·lu·tri·ate (ĭ-lōō′trē-āt′) *tr.v.* **-at·ed, -at·ing, -ates.** **1.** To purify, separate, or remove (ore, for example) by washing, decanting, and settling. **2.** To wash away the lighter or finer particles of (soil, for example). [Latin *elutriāre, elutriāt-* (from **elutrium,* vat, bath, from Greek **elutrion,* diminutive of *elutron,* sheath, tank; see **ELYTRON**) or *ēlūtriāre* (from **ēlūtor,* one who washes, from *ēluere,* to wash out; see **ELUTE**).] **—e·lu′tri·a′tion** *n.*

e·lu·vi·ate (ĭ-lōō′vē-āt′) *intr.v.* **-at·ed, -at·ing, -ates.** To undergo eluviation.

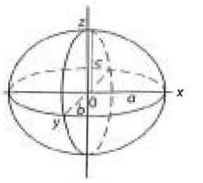
e·lu·vi·a·tion (ĭ-lōō′vē-ā′shən) *n.* The lateral or downward movement of dissolved or suspended material within soil when rainfall exceeds evaporation. [ELUVI(UM) + **-ATION.**]

e·lu·vi·um (ĭ-lōō′vē-əm) *n.* Residual deposits of soil, dust, and rock particles produced by the action of the wind. [New Latin *ēluvium,* from Latin *ēluere,* to wash out. See **ELUTE.**] **—e·lu′vi·al** (-əl) *adj.*

el·ver (ĕl′vər) *n.* See **glass eel.** [Alteration of *eelfare,* a brood



ellipse



ellipsoid

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$$

El Salvador

ă pat	oi boy
ā pay	ou out
âr care	o͝o took
ä father	o͞o boot
ĕ pet	ŭ cut
ē be	û̆r urge
ĭ pit	th thin
ī pie	*th* this
îr pier	hw which
ŏ pot	zh vision
ō toe	ə about, item
ô paw	♦ regionalism

Stress marks: ′ (primary); ″ (secondary), as in **dictionary** (dĭk′shə-nĕr′ē)

cant: *an expressive glance.* —**ex·pres′sive·ly** *adv.* —**ex·pres′sive·ness** *n.*

SYNONYMS: *expressive, eloquent, meaningful, significant.* The central meaning shared by these adjectives is "effectively conveying a feeling, an idea, or a mood": *an expressive gesture; an eloquent speech; a meaningful look; a significant smile.*

ex·pres·siv·i·ty (ĕk′sprĕ-sĭv′ĭ-tē) *n., pl.* **-ties.** **1.** The quality of being expressive. **2.** *Genetics.* The degree to which an expressed gene produces its effects in an organism.

ex·press·ly (ĭk-sprĕs′lē) *adv.* **1.** In an express or a definite manner; explicitly: *I expressly ordered the visitor to leave.* **2.** Especially; particularly: *tools designed expressly for left-handed workers.*

ex·pres·so (ĭk-sprĕs′ō, ĕk-) *n.* Variant of **espresso.**

ex·press·way (ĭk-sprĕs′wā′) *n.* *Abbr.* **expy** A major divided highway designed for high-speed travel. Also called *freeway, superhighway, thruway.*

ex·pro·pri·ate (ĕk-sprō′prē-āt′) *tr.v.* **-at·ed, -at·ing, -ates.** **1.** To deprive of possession: *expropriated the property owners who lived in the path of the new highway.* **2.** To transfer property to oneself. [Medieval Latin *expropriāre, expropriāt-* : Latin *ex-*, ex- + Latin *propriāre*, to appropriate (from *proprius*, one's own; see PROPER).] —**ex·pro′pri·a′tion** *n.* —**ex·pro′pri·a′tor** *n.* —**ex·pro′pri·a·to′ry** (-ə-tôr′ē, -tōr′ē) *adj.*

expt. *abbr.* Experiment.

exptl. *abbr.* Experimental.

ex·pul·sion (ĭk-spŭl′shən) *n.* The act of expelling or the state of being expelled. [Middle English *expulsioun*, from Old French *expulsion*, from Latin *expulsiō, expulsiōn-*, from *expulsus*, past participle of *expellere*, to expel. See EXPEL.]

ex·punc·tion (ĭk-spŭngk′shən, -spŭng′shən) *n.* The act of expunging or the condition of being expunged: *expunction of the records of the crime.* [Late Latin *expunctiō, expunctiōn-*, execution, from Latin *expunctus*, past participle of *expungere*, to strike out. See EXPUNGE.]

ex·punge (ĭk-spŭnj′) *tr.v.* **-punged, -pung·ing, -pung·es.** **1.** To erase or strike out: *"I have corrected some factual slips, expunged some repetitions"* (Kenneth Tynan). **2.** To eliminate completely; annihilate. See Synonyms at **erase.** [Latin *expungere* : *ex-*, ex- + *pungere*, to prick; see **peuk-** in Appendix.] —**ex·pung′er** *n.*

ex·pur·gate (ĕk′spər-gāt′) *tr.v.* **-gat·ed, -gat·ing, -gates.** To remove erroneous, vulgar, obscene, or otherwise objectionable material from (a book, for example) before publication. [Latin *expūrgāre, expūrgāt-*, to purify : *ex-*, intensive pref.; see EX- + *purgāre*, to cleanse; see **peuə-** in Appendix.] —**ex′pur·ga′tion** *n.* —**ex′pur·ga′tor** *n.*

ex·pur·ga·to·ry (ĭk-spûr′gə-tôr′ē, -tōr′ē) also **ex·pur·ga·to·ri·al** (-tôr′ē-əl, -tōr′-) *adj.* Of or relating to expurgation or an expurgator.

expy *abbr.* Expressway.

ex·qui·site (ĕk′skwĭ-zĭt, ĭk-skwĭz′ĭt) *adj.* **1.** Characterized by intricate and beautiful design or execution: *an exquisite chalice.* **2.** Of such beauty or delicacy as to arouse delight: *an exquisite sunset.* See Synonyms at **delicate.** **3.** Excellent; flawless: *plays the piano with exquisite technique.* **4.** Acutely perceptive or discriminating: *an exquisite sense of color.* **5.** Intense; keen: *suffered exquisite pain.* **6.** *Obsolete.* Ingeniously devised or thought out. —**exquisite** *n.* One who is excessively fastidious in dress, manners, or taste. [Middle English *exquisit*, carefully chosen, from Latin *exquīsītus*, past participle of *exquīrere*, to search out : *ex-*, ex- + *quaerere*, to seek.] —**ex′qui·site·ly** *adv.* —**ex′qui·site·ness** *n.*

exr. *abbr.* Executor.

exrx. *abbr.* Executrix.

ex·san·gui·nate (ĕks-săng′gwə-nāt′) *tr.v.* **-nat·ed, -nat·ing, -nates.** To drain of blood. [From Latin *exsanguinātus*, drained of blood : *ex-*, ex- + *sanguis, sanguin-*, blood.] —**ex·san′gui·na′tion** *n.*

ex·san·guine (ĕks-săng′gwĭn) *adj.* Lacking blood; anemic. [Latin *exsanguis, exsanguin-* : *ex-*, ex- + *sanguis*, blood.]

ex·scind (ĭk-sĭnd′) *tr.v.* **-scind·ed, -scind·ing, -scinds.** To cut out; excise. [Latin *exscindere* : *ex-*, ex- + *scindere*, to cut; see **skei-** in Appendix.]

ex·sert (ĭk-sûrt′) *tr.v.* **-sert·ed, -sert·ing, -serts.** To thrust (something) out or forth; cause to protrude. —**exsert** Also **ex·sert·ed** (-sûr′tĭd) *adj.* Thrust outward or protruding, as stamens projecting beyond petals. [Latin *exserere, exsert-*. See EXERT.] —**ex·ser′tion** *n.*

ex·sic·cate (ĕk′sĭ-kāt′) *intr. & tr.v.* **-cat·ed, -cat·ing, -cates.** To dry up or cause to dry up. [Middle English *exsiccaten*, from Latin *exsiccāre, exsiccāt-* : *ex-*, ex- + *siccāre*, to dry (from *siccus*, dry).] —**ex′sic·ca′tion** *n.* —**ex′sic·ca′tive** *adj.* —**ex′sic·ca′tor** *n.*

ex·stip·u·late (ĕks-stĭp′yə-lĭt) *adj.* *Botany.* Having no stipules.

ext. *abbr.* **1.** Extension. **2.a.** External. **b.** Externally. **3.** Extinct. **4.** Extra. **5.** Extract.

ex·tant (ĕk′stənt, ĕk-stănt′) *adj.* **1.** Still in existence; not destroyed, lost, or extinct: *extant manuscripts.* **2.** *Archaic.* Standing out; projecting. [Latin *exstāns, exstant-*, present participle of *exstāre*, to stand out : *ex-*, ex- + *stāre*, to stand; see **stā-** in Appendix.]

ex·tem·po·ral (ĭk-stĕm′pər-əl) *adj.* *Archaic.* Extemporaneous. [Latin *extemporālis*, from *ex tempore*. See EXTEMPORE.]

ex·tem·po·ra·ne·ous (ĭk-stĕm′pə-rā′nē-əs) *adj.* **1.** Carried out or performed with little or no preparation; impromptu: *an extemporaneous piano recital.* **2.** Prepared in advance but delivered without notes or text: *an extemporaneous speech.* **3.** Skilled at or given to unrehearsed speech or performance: *an accomplished extemporaneous speaker.* **4.** Provided, made, or adapted as an expedient; makeshift: *an extemporaneous policy decision.* [From Late Latin *extemporāneus*, from Latin *ex tempore*. See EXTEMPORE.] —**ex·tem′po·ra·ne′i·ty** (-pər-ə-nē′ĭ-tē) *n.* —**ex·tem′po·ra′ne·ous·ly** *adv.* —**ex·tem′po·ra′ne·ous·ness** *n.*

SYNONYMS: *extemporaneous, extemporary, extempore, impromptu, offhand, unrehearsed, unpremeditated, ad-lib.* These adjectives mean spoken, performed, done, or composed with little or no preparation or forethought. *Extemporaneous, extemporary,* and *extempore* most often apply to discourse, as a public speech, that is delivered without the assistance of a written text, though it may have been planned in advance: *an extemporaneous address; an extemporary lecture; an extempore skit. Impromptu* even more strongly suggests action or expression that comes on the spur of the moment in response to an unforeseen need: *an impromptu speech; an impromptu dinner. Offhand* implies not only spontaneity but also a casual or even cavalier manner: *an offhand remark.* What is *unrehearsed* is said or done without rehearsal or practice though not necessarily without forethought: *a few unrehearsed comments. Unpremeditated* applies to action taken without prior thought or plan; often the term implies impulsiveness prompted by strong feeling: *asked an unpremeditated question.* Something that is *ad-lib* is spontaneous and improvised and therefore not part of a prepared script or score: *an ad-lib joke; an ad-lib solo.*

ex·tem·po·rar·y (ĭk-stĕm′pə-rĕr′ē) *adj.* Spoken, done, or composed with little or no preparation or forethought. See Synonyms at **extemporaneous.** [From EXTEMPORE.] —**ex·tem′po·rar′i·ly** (-rār′ə-lē) *adv.*

ex·tem·po·re (ĭk-stĕm′pə-rē) *adj.* Spoken, carried out, or composed with little or no preparation or forethought. See Synonyms at **extemporaneous.** —**extempore** *adv.* In an extemporaneous manner. [Latin *ex tempore* : *ex*, of; see EX- + *tempore*, ablative of *tempus*, time.]

ex·tem·po·rize (ĭk-stĕm′pə-rīz′) *v.* **-rized, -riz·ing, -riz·es.** —*tr.* To do or perform (something) without prior preparation or practice: *extemporized an acceptance speech.* —*intr.* To perform an act or utter something in an impromptu manner; improvise: *"bravely demonstrating his ability to extemporize intelligently"* (William Safire). —**ex·tem′po·ri·za′tion** (-pər-ĭ-zā′shən) *n.* —**ex·tem′po·riz′er** *n.*

ex·tend (ĭk-stĕnd′) *v.* **-tend·ed, -tend·ing, -tends.** —*tr.* **1.** To open or straighten (something) out; unbend: *extended the legs of the folding table.* **2.** To stretch or spread (something) out to greater or fullest length: *extended the radio antenna.* **3.a.** To exert (oneself) vigorously or to full capacity: *Few mountain climbers have extended themselves as those two have.* **b.** To cause to move at full gallop. Used of a horse. **4.a.** To increase in quantity or bulk by adding a cheaper substance: *used rice or pasta to extend leftover casseroles.* **b.** To adulterate. **5.a.** To enlarge the area, scope, or range of. **b.** To expand the influence of. **c.** To make more comprehensive or inclusive. See Synonyms at **increase.** **6.a.** To offer: *extend one's greetings.* **b.** To make available; provide: *extend credit to qualified purchasers.* **7.a.** To cause (something) to be or last longer: *extended our visit by a day.* **b.** To prolong the time allowed for payment of: *extend a loan for three more months.* **8.** *Chiefly British.* **a.** To appraise or assess; value. **b.** To seize or make a levy on for the purpose of settling a debt. —*intr.* To be or become long, large, or comprehensive: *influence that extended to other continents; table legs that extend by unscrewing.* [Middle English *extenden*, from Old French *extendre*, from Latin *extendere* : *ex-*, ex- + *tendere*, to stretch; see **ten-** in Appendix.] —**ex·tend′i·bil′i·ty** *n.* —**ex·tend′a·ble, ex·tend′i·ble** *adj.*

ex·tend·ed (ĭk-stĕn′dĭd) *adj.* **1.** Stretched or pulled out: *an extended telescope.* **2.** Continued for a long period of time; protracted: *had an extended vacation in the Alps.* **3.** Enlarged or broad in meaning, scope, or influence: *an extended sense of the word honest.* —**ex·tend′ed·ly** *adv.*

extended family *n.* **1.** A family group that consists of parents, children, and other close relatives, often living in close proximity. **2.** A group of relatives, such as those of three generations, who live in close geographic proximity rather than under the same roof.

ex·tend·er (ĭk-stĕn′dər) *n.* A substance added to another substance to modify, dilute, or adulterate it: *meat loaf that contained oatmeal as an extender.*

ex·ten·si·ble (ĭk-stĕn′sə-bəl) *adj.* **1.** Capable of being extended or protruded: *an extensible tongue; extensible tables.* **2.** *Computer Science.* Of or relating to a programming language or a system that can be modified by changing or adding features. —**ex·ten′si·bil′i·ty** *n.*

ex·ten·sile (ĭk-stĕn′sĭl) *adj.* Extensible.

ex·ten·sion (ĭk-stĕn′shən) *n.* *Abbr.* **ext.** **1.** The act of ex-

ă pat	oi boy
ā pay	ou out
âr care	o͝o took
ä father	o͞o boot
ĕ pet	ŭ cut
ē be	ûr urge
ĭ pit	th thin
ī pie	*th* this
îr pier	hw which
ŏ pot	zh vision
ō toe	ə about, item
ô paw	♦ regionalism

Stress marks: ′ (primary); ″ (secondary), as in **dictionary** (dĭk′shə-nĕr′ē)

...ristic who attempted to identify the common elements shared by Christianity, Islam, and Judaism.

lu·lu (lo͞o′lo͞o) *n. Slang.* A remarkable person, object, or idea. [Alteration (probably influenced by the nickname *Lulu*) of obsolete *looly*.]

lum·ba·go (lŭm-bā′gō) *n.* A painful condition of the lower back, as one resulting from muscle strain or a slipped disk. [Late Latin *lumbāgō*, from Latin *lumbus*, loin.]

lum·bar (lŭm′bər, -bär′) *adj.* Of, near, or situated in the part of the back and sides between the lowest ribs and the pelvis. —**lumbar** *n.* A lumbar artery, nerve, vertebra, or part. [New Latin *lumbāris*, from Latin *lumbus*, loin.]

lumbar puncture *n.* The insertion of a hollow needle beneath the arachnoid membrane of the spinal cord in the lumbar region to withdraw cerebrospinal fluid for diagnostic purposes or to administer medication.

lum·ber[1] (lŭm′bər) *n.* **1.** Timber sawed into boards, planks, or other structural members of standard or specified length. **2.** Seemingly useless or cumbersome. **3.** *Chiefly British.* Miscellaneous stored articles. —**lumber** *v.* **-bered, -ber·ing, -bers.** *tr.* **1.a.** To cut down (trees) and prepare as marketable timber. **b.** To cut down the timber of. **2.** *Chiefly British.* To clutter with or as if with unused articles. —*intr.* To cut and prepare timber for marketing. [Perhaps from LUMBER[2].] —**lum′ber** *adj.* —**lum′ber·er** *n.*

lum·ber[2] (lŭm′bər) *intr.v.* **-bered, -ber·ing, -bers.** **1.** To walk or move with heavy clumsiness. See Synonyms at **blunder.** **2.** To move with a rumbling noise. [Middle English *lomeren*, possibly of Scandinavian origin; akin to Swedish dialectal *loma*, to move heavily.] —**lum′ber·ing·ly** *adv.*

lum·ber·jack (lŭm′bər-jăk′) *n.* **1.** One who fells trees and transports the timber to a mill; a logger. **2.** A short, warm outer jacket. Also called *lumber jacket.*

Lum·ber·ton (lŭm′bər-tən). A city of southern North Carolina south of Fayetteville. It is a tobacco market with lumber and textile mills. Population, 18,340.

lum·ber·yard (lŭm′bər-yärd′) *n.* An establishment that sells lumber and other building materials from a yard.

lum·bri·coid (lŭm′brĭ-koid′) *adj.* Of or resembling an earthworm. [From New Latin *lumbrīcoidēs*, species of intestinal parasitic roundworm : Latin *lumbrīcus*, earthworm + -OID.]

lu·men (lo͞o′mən) *n., pl.* **-mens** or **-mi·na** (-mə-nə). **1.** *Anatomy.* The inner open space or cavity of a tubular organ, as of a blood vessel or an intestine. **2.** *Abbr.* **lm** *Physics.* The unit of luminous flux in the International System, equal to the amount of light given out through a solid angle by a source of one candela intensity radiating equally in all directions. See table at **measurement.** **3.** *Botany.* The cavity bounded by a plant cell wall. [Latin, an opening, light. See **leuk-** in Appendix.] —**lu′men·al, lu′min·al** *adj.*

Lu·mière (lo͞o-myĕr′, lü-), **Auguste Marie Louis Nicolas.** 1862–1954. French chemist, inventor, and cinematography pioneer. With his brother **Louis Jean Lumière** (1864–1948) he gave the first public showing of a cinematic film (1895).

lu·mi·nance (lo͞o′mə-nəns) *n.* **1.** The condition or quality of being luminous. **2.** *Physics.* The intensity of light per unit area of its source.

♦lu·mi·nar·i·a (lo͞o′mə-nâr′ē-ə) *n.* **1.** *Southwestern U.S.* A votive candle set into a small, decorative paper bag weighted with sand and placed in a row with others along a walkway, driveway, or rooftop as a holiday decoration. Also called ♦*farolito.* **2.** *New Mexico.* A bonfire built in front of each house in a pueblo to celebrate Christmas Eve. [Spanish, from Latin *lūmināria*, pl. of *lūmināre*, lamp. See LUMINARY.]

♦**REGIONAL NOTE:** In recent years it has become commonplace to see entire American neighborhoods decorated during holiday seasons with *luminarias* lining driveways, sidewalks, or rooftops. A luminaria is a votive candle set inside a small decorative paper bag weighted with sand. The bags are usually colored and often perforated with designs through which the candle inside shows as bright pinpricks of light. The custom of luminarias comes from Mexico and is associated especially with the southwest United States. The same word is used for a similar holiday custom of the Pueblo peoples in New Mexico. On Christmas Eve they build a bonfire, called a *luminaria*, outside each house in the pueblo.

lu·mi·nar·y (lo͞o′mə-nĕr′ē) *n., pl.* **-ies.** **1.** An object, such as a celestial body, that gives light. **2.** A person who is an inspiration to others. **3.** A person who has achieved eminence in a specific field. See Synonyms at **celebrity.** [Middle English, from Old French *luminarie*, from Latin *lūmināre* to shine, from *lūmen*, light. See **leuk-** in Appendix.] —**lu′mi·nar′y** *adj.*

lu·mi·nesce (lo͞o′mə-nĕs′) *intr.v.* **-nesced, -nesc·ing, -nescences.** To be or become luminescent. [Back-formation from LUMINESCENCE.]

lu·mi·nes·cence (lo͞o′mə-nĕs′əns) *n.* **1.** The emission of light that does not derive energy from the temperature of the emitting body, as in phosphorescence, fluorescence, and bioluminescence. Luminescence is caused by chemical, biochemical, or crystallographic changes, the motions of subatomic particles, or radiation-induced excitation of an atomic system. **2.** The light so emitted.

lu·mi·nes·cent (lo͞o′mə-nĕs′ənt) *adj.* Capable of, suitable for, or exhibiting luminescence. [Latin *lūmen, lūmin-*, light; see LUMEN + -ESCENT.]

lu·mi·nif·er·ous (lo͞o′mə-nĭf′ər-əs) *adj.* Generating, yielding, or transmitting light. [Latin *lūmen, lūmin-*, light; see LUMEN + -FEROUS.]

lu·mi·nism also **Lu·mi·nism** (lo͞o′mə-nĭz′əm) *n.* A style of 19th-century American painting concerned especially with the precise, realistic rendering of atmospheric light and the perceived effects of that light on depicted objects. [Latin *lūmen, lūmin-*, light; see LUMEN + -ISM.] —**lu′mi·nist** *adj. & n.*

lu·mi·nos·i·ty (lo͞o′mə-nŏs′ĭ-tē) *n., pl.* **-ties.** **1.** The condition or quality of being luminous. **2.** Something luminous. **3.** The ratio of luminous flux at a specific wavelength to the radiant flux at the same wavelength. In this sense, also called *luminosity factor.*

lu·mi·nous (lo͞o′mə-nəs) *adj.* **1.** Emitting light, especially emitting self-generated light. **2.** Full of light; illuminated. See Synonyms at **bright.** **3.a.** Easily comprehended; clear: *luminous prose.* **b.** Enlightened and intelligent; inspiring: *luminous ideas.* [Middle English, from Old French *lumineux*, from Latin *lūminōsus*, from *lūmen, lūmin-*, light. See **leuk-** in Appendix.] —**lu′mi·nous·ly** *adv.* —**lu′mi·nous·ness** *n.*

luminous efficiency *n.* The ratio of the total luminous flux to the total radiant flux of an emitting source.

luminous energy *n.* The radiant energy of electromagnetic waves in the visible portion of the electromagnetic spectrum.

luminous flux *n.* The rate of flow of light per unit of time, especially the flux of visible light expressed in lumens.

luminous intensity *n.* The luminous flux density per solid angle as measured in a given direction relative to the emitting source.

lum·mox (lŭm′əks) *n. Informal.* A person regarded as clumsy or stupid. [Origin unknown.]

lump[1] (lŭmp) *n.* **1.** An irregularly shaped mass or piece. **2.** A small cube of sugar. **3.** *Pathology.* A swelling or small palpable mass. **4.** A collection or totality; an aggregate. **5.** A person regarded as ungainly or dull witted. **6. lumps.** *Informal.* **a.** Severe punishment or treatment, as a beating or an unsparing criticism: *take one's lumps.* **b.** One's just deserts; comeuppance: *get one's lumps.* —**lump** *adj.* **1.** Formed into lumps: *lump sugar.* **2.** Not broken or divided into parts: *a lump payment.* —**lump** *v.* **lumped, lump·ing, lumps.** —*tr.* **1.** To put together in a single group without discrimination. **2.** To move with heavy clumsiness. **3.** To make into lumps. —*intr.* **1.** To become lumpy. **2.** To move heavily. —***idiom.*** **lump in (one's) throat.** A feeling of constriction in the throat caused by emotion. [Middle English *lumpe*, of Low German origin; akin to obsolete Dutch *lompe*.]

lump[2] (lŭmp) *tr.v.* **lumped, lump·ing, lumps.** *Informal.* To tolerate (what must be endured): *like it or lump it.* [Perhaps from dialectal *lump*, to look sullen.]

lump·ec·to·my (lŭm-pĕk′tə-mē) *n., pl.* **-mies.** Surgical excision of a tumor from the breast with the removal of a minimal amount of surrounding tissue.

lum·pen (lŭm′pən, lo͝om′-) *adj.* **1.** Of or relating to dispossessed, often displaced people who have been cut off from the socioeconomic class with which they would ordinarily be identified: *lumpen intellectuals unable to find work in their fields.* **2.** Of or relating to the lumpenproletariat. **3.** Boorish or unenlightened: *Her music found no audience among the lumpen bourgeoisie.* [From German *Lumpenproletariat*, the lowest section of the proletariat. See LUMPENPROLETARIAT.]

lum·pen·pro·le·tar·i·at (lŭm′pən-prō′lĭ-târ′ē-ət, lo͝om′-) *n.* **1.** The lowest, most degraded stratum of the proletariat. Used originally in Marxist theory to describe those members of the proletariat, especially criminals, vagrants, and the unemployed, who lacked class consciousness. **2.** The underclass of a human population. [German : *Lumpen*, pl. of *Lump*, ragamuffin (from Middle High German *lumpe*, rag) + *Proletariat*, proletariat (from French *prolétariat*; see PROLETARIAT).]

lump·fish (lŭmp′fĭsh′) *n., pl.* **lumpfish** or **-fishes.** Any of various fishes of the family Cyclopteridae, especially *Cyclopterus lumpus* of North Atlantic waters, having pelvic fins united to form a suction disk and a body bearing prominent tubercles. [Obsolete *lump*, lumpfish (perhaps from Dutch *lomp*, blenny, loach, from Middle Dutch *lompe*, cod) + FISH.]

lump·ish (lŭm′pĭsh) *adj.* **1.** Stupid or dull. **2.** Clumsy or cumbersome. —**lump′ish·ly** *adv.* —**lump′ish·ness** *n.*

lump sum *n.* A single sum of money that serves as complete payment. —**lump′-sum′** (lŭmp′sŭm′) *adj.*

lump·y (lŭm′pē) *adj.* **-i·er, -i·est.** **1.** Covered or filled with lumps. **2.** Thickset or cumbersome. **3.** Exhibiting short, jumbled waves, as a tidal rip. —**lump′i·ly** *adv.* —**lump′i·ness** *n.*

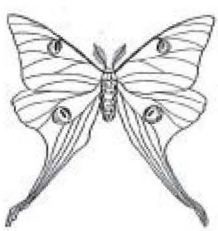
lumpy jaw *n.* See **actinomycosis.**

Lu·mum·ba (lo͞o-mo͝om′bə), **Patrice Emergy.** 1925–1961. First prime minister (1960–1961) of the Congo (now Zaire).

Lu·na (lo͞o′nə) *n. Roman Mythology.* The goddess of the moon. [Latin *Lūna*, from *lūna*, moon. See **leuk-** in Appendix.]

lu·na·cy (lo͞o′nə-sē) *n., pl.* **-cies.** **1.** Insanity, especially insanity relieved intermittently by periods of clear-mindedness. See Synonyms at **insanity.** **2.a.** Great foolishness. **b.** A wildly foolish act. **3.** *Archaic.* Intermittent mental derangement associated with the changing phases of the moon. [From LUNATIC.]

lu·na moth (lo͞o′nə) *n.* A large, pale-green North American



luna moth
Actias luna

ă pat	oi boy
ā pay	ou out
âr care	o͝o took
ä father	o͞o boot
ĕ pet	ŭ cut
ē be	ûr urge
ĭ pit	th thin
ī pie	*th* this
îr pier	hw which
ŏ pot	zh vision
ō toe	ə about, item
ô paw	♦ regionalism

Stress marks: ′ (primary); ″ (secondary), as in **dictionary** (dĭk′shə-nĕr′ē)

(mĕl′ə-dē) *n., pl.* **-dies.** **1.** A pleasing succession or of sounds. **2.** Musical quality: *the melody of verse.* **a.** A rhythmically organized sequence of single tones to one another as to make up a particular phrase or tructure with respect to the arrangement of single notes on. **c.** The leading part or the air in a harmonic com- **3.** A poem suitable for setting to music or singing. nglish *melodie,* from Old French, from Late Latin *melō-* Greek *melōidia,* singing choral song : *melos,* tune + see **wed-**[2] in Appendix.]

(mĕl′oid′, mēl′ō-ĭd) *n.* See **blister beetle.** —**meloid** relating to blister beetles. [From New Latin *Meloidae,* from *Meloe,* type genus.]

(mĕl′ən) *n.* **1.** Any of several varieties of two related *mis melo* or *Citrullus lanatus)* widely cultivated for esfruit. **2.** The fruit of any of these plants, having a nd juicy flesh. [Middle English, from Old French, from *mēlō, mēlōn-,* short for Latin *mēlopepō,* from Greek *mēlon,* apple + *pepōn,* gourd.]

n·gene (mĕl′ən-jēn′) *n.* See **eggplant** (sense 1). *longène,* from Old French *melanjan, melonge,* from tin *melongēna,* from Old Italian *melanzana, melon-* Medieval Greek *melintzana, melanzana,* alteration by Greek *melas,* dark) of Arabic *bādinjān,* from Per- *dingān.*]

(mē′lôs). See **Milos.**

m·ē·ne (mĕl-pŏm′ə-nē′) *n. Greek Mythology.* The agedy.

se (mĕl′rōz′). A city of northeast Massachusetts, a res- burb of Boston. Population, 30,005.

e Park. A village of northeast Illinois, an industrial hicago. Population, 20,735.

) *v.* **melt·ed, melt·ing, melts.** —*intr.* **1.** To be from a solid to a liquid state by application of heat or both. **2.** To dissolve: *Sugar melts in water.* **3.** To or vanish gradually as if by dissolving: *The crowd melt- ter the rally.* **4.** To pass or merge imperceptibly into else: *Sea melted into sky along the horizon.* **5.** To softened in feeling: *Our hearts melted at the child's tears.* To be overcome or crushed, as by grief, dismay, or —*tr.* **1.** To change (a solid) to a liquid state by the appli- eat or pressure or both. **2.** To dissolve: *The tide melted astle away.* **3.** To cause to disappear gradually; dis- **4.** To cause (units) to blend: *"Here individuals of all races into a new race of men"* (Michel Guillaume Jean de). **5.** To soften (someone's feelings); make gentle or —**melt** *n.* **1.** A melted solid; a fused mass. **2.** The state melted. **3.a.** The act or operation of melting. **b.** The melted at a single operation or in one period. **4.** A usu- andwich topped with melted cheese: *a tuna melt.* e. Often used to modify another noun: *glacial melt summer melt season.* [Middle English *melten,* from *meltan.* See **mel-**[1] in Appendix.] —**melt′a·bil′i·ty** —**melt′a·ble** *adj.* —**melt′er** *n.* —**melt′ing·ly** *adv.* —**melt′y**

NYMS: *melt, fuse, liquefy, thaw, deliquesce.* These verbs nge or cause to change into a liquid. *Melt* implies caused principally by heat: *The candle softened and e sun. I melted the butter in a saucepan.* Figuratively suggests gradual dispersion, dissipation, and disappear- *They melt like mist, the solid lands"* (Tennyson). *"The usu- of their manner . . . has . . . melted away"* (Thomas De Melt can also mean to become softened in feeling, as pity, sympathy, or love: *His heart melted at the sight of child. Fuse* primarily suggests the union of different nts, such as two minerals, by or as if by heating: *"It is the dable kind of faith—the kind that is emotionally fused onal pride"* (Conor Cruise O'Brien). *Liquefy,* unlike the rms in this group, is restricted to physical processes but is both gases and solids: *a process that is used to liquefy Thaw* applies to the partial or complete melting of some- such as ice, that is frozen; figuratively it suggests the soft- dissolution of something, as of formality or reserve, lik- frozen substance: *"The short, shy manner of their white- thawed under the influence of Mrs. Elsmere's racy, ways"* (Mrs. Humphry Ward). To *deliquesce* is to be- d, usually gradually, through absorption of moisture *"Pure chloride of sodium is not liable to deliquesce"* ge).

ge (mĕl′tĭj) *n.* **1.** The substance or quantity of a sub- duced by a melting process. **2.** The act or process of

down (mĕlt′doun′) *n.* **1.** Severe overheating of a nuclear re, resulting in melting of the core and escape of radi- **2.** *Informal.* A situation likened to the melting of a nuclear e. *"After several corporate meltdowns, only two report- in* [the] *bureau"* (David Fitzpatrick).

ing point (mĕl′tĭng) *n. Abbr.* **mp, m.p.** *Chemistry.* **1.** erature at which a solid becomes a liquid at standard eric pressure. **2.** The temperature at which a solid and are in equilibrium, at any fixed pressure.

ing pot *n.* **1.** A container in which a substance is melted. **2.** A place where immigrants of different cultures or races form an integrated society: *"Canadians . . . liked to think of their country as a mosaic rather than a melting pot"* (Kenneth McNaught).

mel·ton (mĕl′tən) *n.* A heavy woolen cloth used chiefly for making overcoats and hunting jackets. [After *Melton* Mowbray, an urban district of central England.]

Mel·ville (mĕl′vĭl), **Herman.** 1819–1891. American writer whose experiences at sea provided the factual basis of his allegorical masterpiece *Moby Dick* (1851), considered among the greatest American novels. —**Mel·vil′le·an** (-vĭl′ē-ən) *adj.*

Melville, Lake. A saltwater lake of Newfoundland, Canada, in southeast Labrador. It receives the Churchill River in Goose Bay, its southwest arm.

Melville Island. **1.** An island of northern Australia in the Timor Sea. **2.** An island of northern Northwest Territories, Canada, in the Queen Elizabeth Islands north of Victoria Island.

Melville Peninsula. A peninsula of eastern Northwest Territories, Canada, between Foxe Basin and an arm of the Gulf of Boothia. It is separated from Baffin Island by a narrow strait.

mem (mĕm) *n.* The 13th letter of the Hebrew alphabet. See table at **alphabet.** [Hebrew, perhaps from *mayīm,* water.]

mem. *abbr.* **1.** Member. **2.** Memoir. **3.** Memorandum. **4.** Memorial.

mem·ber (mĕm′bər) *n. Abbr.* **mem.** **1.** A distinct part of a whole, especially: **a.** *Linguistics.* A syntactic unit of a sentence; a clause. **b.** *Logic.* A proposition of a syllogism. **c.** *Mathematics.* An element in a set. **2.** A part or an organ of a human or animal body, as: **a.** A limb, such as an arm or a leg. **b.** The penis. **3.** A part of a plant. **4.** One that belongs to a group or an organization: *a club member; a bank that is a member of the FDIC.* **5.** *Mathematics.* The expression on either side of an equality sign. **6.** A structural unit, such as a beam or wall. [Middle English *membre,* from Old French, from Latin *membrum.*]

member firm *n.* A securities firm with officers or partners who are members of an organized exchange.

mem·ber·ship (mĕm′bər-shĭp′) *n.* **1.** The state of being a member. **2.** The total number of members in a group: *an organization with a growing membership.*

mem·brane (mĕm′brān′) *n.* **1.** *Biology.* **a.** A thin, pliable layer of tissue covering surfaces or separating or connecting regions, structures, or organs of an animal or a plant. **b.** Cell membrane. **2.** A piece of parchment. **3.** *Chemistry.* A thin sheet of natural or synthetic material that is permeable to substances in solution. [Latin *membrāna,* skin, from *membrum,* member of the body.] —**mem′bra·nal** (-brə-nəl) *adj.*

membrane bone *n.* A bone that forms directly in membranous connective tissue, as some cranial bones, instead of developing from cartilage.

mem·bra·nous (mĕm′brə-nəs) *adj.* **1.** Relating to, made of, or similar to a membrane. **2.** *Pathology.* Characterized by the formation of a membrane or a layer similar to a membrane.

membranous labyrinth *n.* The fluid-filled membranous sacs of the inner ear that are associated with the senses of hearing and balance.

Me·mel (mā′məl). See **Klaipeda.**

me·men·to (mə-mĕn′tō) *n., pl.* **-tos** or **-toes.** A reminder of the past; a keepsake. [Middle English, commemoration of the living or the dead in the Canon of the Mass, from Latin *memento,* imperative of *meminisse,* to remember. See **men-**[1] in Appendix.]

memento mo·ri (môr′ē) *n., pl.* **memento mori.** **1.** A reminder of death or mortality, especially a death's-head. **2.** A reminder of human failures or errors. [Medieval Latin **mementō morī,* be mindful of dying : Latin *mementō,* imperative of *meminisse,* to remember + Latin *morī,* to die.]

Mem·ling (mĕm′lĭng) also **Mem·linc** (-lĭngk), **Hans.** 1430?–1494. Flemish painter of portraits and, more notably, religious works, such as the triptych *Adoration of the Magi* (1479).

Mem·non (mĕm′nŏn′) *n. Greek Mythology.* An Ethiopian king killed by Achilles and made immortal by Zeus.

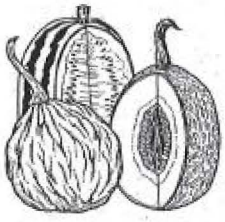
mem·o (mĕm′ō) *n., pl.* **-os.** *Informal.* A memorandum.

mem·oir (mĕm′wär′, -wôr′) *n. Abbr.* **mem.** **1.** An account of the personal experiences of an author. **2.** Often **memoirs.** An autobiography. **3.** A biography or biographical sketch. **4.** A report, especially on a scientific or scholarly topic. **5. memoirs.** The report of the proceedings of a learned society. [French *mémoire,* from Old French *memoire,* memory. See MEMORY.] —**mem′oir·ist** *n.*

mem·o·ra·bil·i·a (mĕm′ər-ə-bĭl′ē-ə, -bĭl′yə) *pl.n.* **1.** Objects valued for their connection with historical events, culture, or entertainment: *posters, publicity photographs, and other movie memorabilia.* **2.** Events or experiences worthy of remembrance: *memorabilia of a life in the theater.* [Latin *memorābilia,* neuter pl. of *memorābilis,* memorable. See MEMORABLE.]

mem·o·ra·ble (mĕm′ər-ə-bəl) *adj.* Worth being remembered or noted: *"memoirs of people who never had a memorable thought"* (George F. Will). [Middle English, from Old French, from Latin *memorābilis,* from *memorāre,* to bring to remembrance, from *memor,* mindful. See **(s)mer-**[1] in Appendix.] —**mem′o·ra·bil′i·ty, mem′o·ra·ble·ness** *n.* —**mem′o·ra·bly** *adv.*

mem·o·ran·dum (mĕm′ə-răn′dəm) *n., pl.* **-dums** or **-da** (-də). *Abbr.* **mem.** **1.** A short note written as a reminder. **2.** A written record or communication, as in a business office. **3.** *Law.*



melon

Herman Melville

ă pat	oi boy
ā pay	ou out
âr care	o͝o took
ä father	o͞o boot
ĕ pet	ŭ cut
ē be	ûr urge
ĭ pit	th thin
ī pie	*th* this
îr pier	hw which
ŏ pot	zh vision
ō toe	ə about, item
ô paw	♦ regionalism

Stress marks: ′ (primary); ″ (secondary), as in **dictionary** (dĭk′shə-nĕr′ē)

Old French, from Late Latin *portārius*, from Latin *porta*, gate. See **per-**[2] in Appendix.]

por·tion (pôr′shən, pōr′-) *n.* **1.** A section or quantity within a larger thing; a part of a whole. **2.** A part separated from a whole. **3.** A part that is allotted to a person or group, as: **a.** A helping of food. **b.** The part of an estate received by an heir. **c.** A woman's dowry. **4.** A person's lot or fate. See Synonyms at **fate.** —**portion** *tr.v.* **-tioned, -tion·ing, -tions.** **1.** To divide into parts or shares for distribution; parcel. **2.** To provide with a share, an inheritance, or a dowry. [Middle English, from Old French, from Latin *portiō, portiōn-*. See **pere-**[2] in Appendix.] —**por′tion·a·ble** *adj.* —**por′tion·er** *n.* —**por′tion·less** *adj.*

Portugal

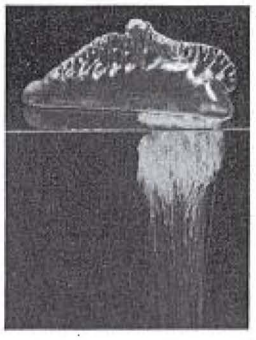
Port·land (pôrt′lənd, pōrt′-). **1.** A city of southwest Maine on an arm of the Gulf of Maine south of Lewiston. Settled c. 1632, it became a commercial center in the 17th century and was state capital from 1820 to 1832. It is the largest city in the state. Population, 61,572. **2.** The largest city of Oregon, in the northwest part of the state on the Willamette River near its junction with the Columbia River. Founded in 1845, it grew as a lumber-exporting port and supply point for the California and Alaska goldfields. Population, 366,383. —**Port′land·er** *n.*

Portland cement or **port·land cement** (pôrt′lənd, pōrt′-) *n.* A hydraulic cement made by heating a mixture of limestone and clay in a kiln and pulverizing the resulting material. [After *Portland*, an urban district of southern England.]

Port Lou·is (lōō′ĭs, lōō′ē, lōō-ē′). The capital and largest city of Mauritius, in the northwest part of the island on the Indian Ocean. It was founded c. 1735. Population, 136,812.

port·ly (pôrt′lē, pōrt′-) *adj.* **-li·er, -li·est.** **1.** Comfortably stout; corpulent. See Synonyms at **fat.** **2.** *Archaic.* Stately; majestic; imposing. [From PORT[5].] —**port′li·ness** *n.*

port·man·teau (pôrt-măn′tō, pōrt-, pôrt′măn-tō′, pōrt′-) *n., pl.* **-teaus** or **-teaux** (-tōz, -tōz′). A large leather suitcase that opens into two hinged compartments. [French *portemanteau* : *porte*, imperative of *porter*, to carry (from Old French; see PORT[5]) + *manteau*, cloak (from Old French *mantel*, from Latin *mantellum*).]


Portuguese man-of-war
Physalia physalis

portmanteau word *n.* A word formed by merging the sounds and meanings of two different words; for example, *slithy*, from *lithe* and *slimy*; *chortle*, from *chuckle* and *snort*.

Port Mores·by (môrz′bē, mōrz′-). The capital and largest city of Papua New Guinea, on southeast New Guinea and the Gulf of Papua. Population, 123,624.

Por·to or **Pôr·to** (pôr′tōō). See **Oporto.**

Pôrto A·le·gre (ə-lĕ′grə). A city of southeast Brazil at the northern end of a large lagoon near the Atlantic Ocean. It was founded c. 1742 by emigrants from the Azores. Population, 1,125,477.

port of call *n., pl.* **ports of call.** A port where ships dock in the course of voyages to load or unload cargo, obtain supplies, or undergo repairs.

port of entry *n., pl.* **ports of entry.** *Abbr.* **POE, P.O.E.** A place where travelers or goods may enter or leave a country under official supervision.

Port of Spain (spān) or **Port-of-Spain** (pôrt′əv-spān′, pōrt′-). The capital of Trinidad and Tobago, on the northwest coast of Trinidad on an arm of the Atlantic Ocean. It is a commercial center and major port. Population, 65,906.

Por·to-No·vo (pôr′tō-nō′vō, pōr′-). The capital of Benin, in the southeast part of the country on an inlet of the Gulf of Guinea. Probably founded in the 16th century, it was settled as a slave-trading center by the Portuguese in the 17th century. Population, 123,000.

Port Or·ange (ôr′ĭnj, ŏr′-). A city of northeast Florida on the Atlantic coast south-southeast of Daytona Beach. It is in a citrus-growing area. Population, 18,756.

Port Or·ford cedar (ôr′fərd) *n.* A tall evergreen coniferous tree (*Chamaecyparis lawsoniana*) native to southwest Oregon and northwest California, having drooping, flattened branches and opposite, scalelike leaves with white markings. [After *Port Orford*, a town of southwest Oregon.]

Pôrto Vel·ho (vĕl′yōō). A city of northwest Brazil on the Madeira River near the Bolivian border. Its economy is based on rubber and Brazil nuts. Population, 101,162.

Port Phil·lip Bay (fĭl′əp). A large deep-water inlet of Bass Strait on the southeast coast of Australia.

por·trait (pôr′trĭt, -trāt′, pōr′-) *n.* **1.** *Abbr.* **por.** A likeness of a person, especially one showing the face, that is created by a painter or photographer, for example. **2.** A verbal picture or description, especially of a person. [French, from Old French, image, from past participle of *portraire*, to portray. See PORTRAY.]

por·trait·ist (pôr′trə-tĭst, pōr-) *n.* A person who makes portraits, especially a painter or photographer.

por·trai·ture (pôr′trĭ-chŏŏr′, pōr′-) *n.* **1.** The art or practice of making portraits. **2.** A portrait. **3.** Portraits considered as a group.

por·tray (pôr-trā′, pōr-) *tr.v.* **-trayed, -tray·ing, -trays.** **1.** To depict or represent pictorially; make a picture of. **2.** To depict or describe in words. **3.** To represent dramatically, as on the stage. See Synonyms at **represent.** [Middle English *portraien*, from Old French *portraire* : *por-*, forth (from Latin *prō-*, forth; see PRO-[1]) + *traire*, to draw (from Latin *trahere*, to drag).] —**por·tray′a·ble** *adj.* —**por·tray′er** *n.*

por·tray·al (pôr-trā′əl, pōr-) *n.* **1.** The act or process of depicting or portraying. **2.** A representation or description.

por·tress (pôr′trĭs, pōr′-) also **por·ter·ess** (-tər-ĭs) *n.* A woman doorkeeper or porter, especially in a convent.

Port Roy·al (roi′əl). See **Annapolis Royal.**

Port Sa·id (sä-ēd′). A city of northeast Egypt on the Mediterranean Sea at the northern entrance to the Suez Canal. It was founded in 1859 by the builders of the canal and was once an important coaling station. Population, 374,000.

Port Sa·lut (pôr′ sä-lōō′, -lü′) also **Port du Sa·lut** (pôrt′ də sä-lōō′, pōrt′, pôr dü sä-lü′) *n.* A semihard fermented cheese made originally by Trappist monks in France. [After Notre Dame de *Port-du-Salut*, a Trappist abbey in northwest France.]

port·side (pôrt′sīd′, pōrt′-) *adv.* & *adj.* **1.** On the waterfront of a port: *taking a stroll portside; a portside restaurant.* **2.** Nautical. On the port side of a ship or boat: *skirting a lighthouse portside; the portside oar.*

Ports·mouth (pôrt′sməth, pōrt′-). **1.** A borough of southern England on the English Channel opposite the Isle of Wight. Chartered in 1194, it is a major naval base. Population, 187,900. **2.** A city of southeast New Hampshire on the Atlantic Ocean. The Treaty of Portsmouth, ending the Russo-Japanese War, was signed at the naval base here in 1905. Population, 26,254. **3.** A city of southern Ohio on the Ohio River south of Columbus. An important industrial and rail center, it has prehistoric mounds and earthworks nearby. Population, 25,943. **4.** A city of southeast Virginia opposite Norfolk. It has been a major naval base since pre-Revolutionary times. Population, 104,577.

Port Stan·ley (stăn′lē). See **Stanley.**

Port Su·dan (sōō-dăn′). A city of northeast Sudan on the Red Sea northeast of Khartoum. It was established after 1905 as a railroad terminus. Population, 206,727.

Por·tu·gal (pôr′chə-gəl, pōr′-). *Abbr.* **Port.** A country of southwest Europe on the western Iberian Peninsula. It includes the Madeira Islands and the Azores in the northern Atlantic Ocean. Originally inhabited by a Celtic people, the mainland was conquered by the Romans in the 2nd century B.C. and subsequently held by the Visigoths and Moors. An independent kingdom was recognized in 1143 and soon flourished as a maritime and colonial power with holdings stretching from Africa to the Far East and Brazil in the New World. Much of its empire was lost to the British and the Dutch in the 17th and 18th centuries, and the remaining colonies in Africa became independent in the 20th century. Lisbon is the capital and the largest city. Population, 9,933,000.

Por·tu·ga·le·te (pôr′tə-gə-lā′tē, pōr′-, pôr′tōō-gə-lĕ′tē). A city of northern Spain, a suburb of Bilbao on the Bay of Biscay. Population, 59,307.

Por·tu·guese (pôr′chə-gēz′, -gēs′, pōr′-) *adj.* *Abbr.* **Pg., Port.** Of or relating to Portugal or its people, language, or culture. —**Portuguese** *n., pl.* **Portuguese.** *Abbr.* **Pg., Port.** **1.** A native or inhabitant of Portugal. **b.** A person of Portuguese descent. **2.** The Romance language of Portugal and Brazil. [*português*, from Vulgar Latin **portugalensis*, ultimately from Late Latin *Portus Cale*, the ancient port of Gaya (Oporto).]

Portuguese man-of-war *n.* A complex colonial siphonophore of the genus *Physalia*, of warm seas, having a bluish bladderlike float with a broad saillike crest from which hang numerous long stinging tentacles.

Portuguese water dog *n.* Any of a breed of strong, medium-sized dog developed in Portugal that is able to swim long distances and is characterized by webbed feet and a curled tail.

por·tu·lac·a (pôr′chə-lăk′ə, pōr′-) *n.* Any of various plants of the genus *Portulaca*, especially *P. grandiflora* of South America, cultivated for its showy, colorful flowers that open in sunlight. Also called *rose moss.* [Middle English, from *portulāca*, purslane, from *portula*, diminutive of *porta*, gate (from the gatelike covering of the seed capsule). See **per-**[2] in Appendix.]

POS *abbr.* Point-of-sale.

pos. *abbr.* **1.** Position. **2.** Positive.

po·sa·da (pō-sä′də, pō-sä′thä) *n.* A Christmas festival celebrating in Latin America that dramatizes the search of Joseph and Mary for lodging. [American Spanish, from Spanish, lodging, from *posar*, to lodge, rest, from Late Latin *pausāre*, to rest, from Latin *pausa*, pause. See PAUSE.]

pose[1] (pōz) *v.* **posed, pos·ing, pos·es.** —*intr.* **1.** To assume or hold a particular position or posture, as in sitting for a portrait. **2.** To affect a particular mental attitude. **3.** To represent oneself falsely; pretend to be other than what one is. —*tr.* **1.** To place in a model, for example) in a specific position. **2.** To set forth in words; propound: *pose a question.* **3.** To put forward; present: *pose a threat.* See Synonyms at **propose.** —**pose** *n.* **1.** A bodily attitude or position, especially one assumed for an artist or photographer. See Synonyms at **posture.** **2.** A studied attitude assumed for effect. See Synonyms at **affectation.** [Middle English *posen*, to place, from Old French *poser*, from Vulgar Latin **pausāre*, from Late Latin *pausāre*, to rest, from Latin *pausa*, pause. See PAUSE.] —**pos′a·ble** *adj.*

pose[2] (pōz) *tr.v.* **posed, pos·ing, pos·es.** To puzzle, confuse, or baffle. [Short for *appose*, to examine closely (from Middle English *apposen*, alteration of *opposen*; see OPPOSE) and from French *poser*, to assume (obsolete) (from Old French

Po·sei·don (pō-sīd′n, pə-) *n.* *Greek Mythology*

To weigh heavily, as on the mind. **3.** To advance eagerly; push forward. **4.** To require haste; be urgent. **5.** To iron clothes or other material. **6.** To assemble closely and in large numbers; crowd. **7.** To employ urgent persuasion or entreaty. **8.** *Sports.* To raise or lift a weight in a press. **9.** *Basketball.* To employ a press. **—press** *n.* **1.** Any of various machines or devices that apply pressure. **2.** Any of various machines used for printing; a printing press. **3.** A place or an establishment where matter is printed. **4.** The art, method, or business of printing. **5.a.** The collecting and publishing or broadcasting of news; journalism in general. **b.** The entirety of media and agencies that collect, publish, transmit, or broadcast the news. **c.** The people involved in the media, as news reporters, photographers, publishers, and broadcasters. **d.** Commentary or coverage especially in newspapers or periodicals: *"Like the pool hall and the tattoo parlor, the motorcycle usually gets a bad press"* (R.Z. Sheppard). **6.** The act of gathering in large numbers or of pushing forward. **7.** A large gathering; a throng. See Synonyms at **crowd**[1]. **8.a.** The act of applying pressure. **b.** The state of being pressed. **9.** The haste or urgency of business or matters. **10.** The set of proper creases in a garment or fabric, formed by ironing. **11.** *Chiefly Northeastern U.S.* An upright closet or case used for storing clothing, books, or other articles. **12.** A viselike device for keeping a racket from warping. **13.** *Sports.* A lift in weightlifting in which the weight is raised to shoulder level and then steadily pushed straight overhead without movement of the legs. **14.** *Basketball.* An aggressive defense tactic in which players guard opponents closely, often over the entire court. **—*idiom.* press the flesh.** *Informal.* To shake hands and mingle with many people, especially while campaigning for public office. [Middle English *pressen*, from Old French *presser*, from Latin *pressāre*, frequentative of *premere*, to press. See **per-**[4] in Appendix.]

press[2] (prĕs) *tr.v.* **pressed, press·ing, press·es.** **1.** To force into service in the army or navy; impress. **2.a.** To take arbitrarily or by force, especially for public use. **b.** To use in a manner different from the usual or intended, especially in an emergency. **—press** *n.* **1.** Conscription or impressment into service, especially into the army or navy. **2.** *Obsolete.* An official warrant for impressing men into military service. [Alteration of obsolete *prest*, to hire for military service by advance payment, from Middle English, enlistment money, loan, from Old French, from *prester*, to lend, from Medieval Latin *praestāre*, from Latin, to furnish, from *praestō*, present, at hand.]

press agency *n.* See **news agency.**

press agent *n.* *Abbr.* **PA, P.A.** A person employed to arrange advertising and publicity, as for a performer or for a business. **—press agentry** *n.*

press association *n.* See **news agency.**

press·board (prĕs′bôrd′, -bōrd′) *n.* **1.** A heavy glazed paper or pasteboard used especially to cover the platen or cylinder of a printing press. **2.** A small ironing board.

press box *n.* A section for reporters, as in a stadium.

press conference *n.* An interview held for news reporters by a political figure or a famous person. Also called *news conference.*

press·er (prĕs′ər) *n.* **1.** One who presses clothes. **2.** Any of various devices that apply pressure to a product in manufacturing or canning.

press gang also **press·gang** (prĕs′găng′) *n.* A company of men under an officer detailed to force men into military or naval service.

press-gang (prĕs′găng′) *tr.v.* **-ganged, -gang·ing, -gangs.** **1.** To force into military or naval service. **2.** To force or coerce: *"press-ganging a consumer into buying something he doesn't want"* (Feona McEwan).

press·ing (prĕs′ĭng) *adj.* **1.** Demanding immediate attention; urgent: *a pressing need.* See Synonyms at **urgent.** **2.** Very earnest or persistent; insistent: *a pressing invitation.* **—pressing** *n.* **1.** The process or an instance of applying pressure by means of a press. **2.a.** A phonograph record pressed from a master mold or matrix. **b.** A number of recordings pressed at the same time. **3.** Urgent solicitation; insistence. **—press′ing·ly** *adv.*

press kit *n.* A packaged set of promotional materials, such as photographs and background information, for distribution to the press, as before the release of a new product.

press·man (prĕs′mən, -măn′) *n.* **1.** A man who operates a printing press. **2.** *Chiefly British.* A newspaper reporter.

press·mark (prĕs′märk′) *n.* **1.** *Printing.* A notation or figure in the margin of a printed sheet indicating the press on which it was printed. **2.** *Chiefly British.* A notation in or on a book indicating where it should be placed in a library.

press of sail *n.* *Nautical.* The greatest amount of sail that a ship can carry safely. Also called *press of canvas.*

pres·sor (prĕs′ôr′, -ər) *adj.* Causing an increase in blood pressure. [Late Latin, one who presses, from Latin *premere, press-*, to press. See PRESS[1].]

press release *n.* An announcement of an event, a performance, or other newsworthy item that is issued to the press.

press·room (prĕs′rōōm′, -rŏŏm′) *n.* The room in a printing or newspaper publishing establishment that contains the presses.

press run or **press·run** (prĕs′rŭn′) *n.* **1.** Continuous operation of a printing press for a specific job. **2.** The number of copies printed in one such continuous operation.

press secretary *n.* One who officially manages the public affairs and press conferences of a public figure.

pres·sure (prĕsh′ər) *n.* **1.a.** The act of pressing. **b.** The condition of being pressed. **2.** The application of continuous force by one body on another that it is touching; compression. **3.** *Abbr.* P. *Physics.* Force applied uniformly over a surface, measured as force per unit of area. **4.** *Meteorology.* Atmospheric pressure. **5.** A compelling or constraining influence, such as a moral force, on the mind or will: *pressure to conform; peer-group pressure.* **6.** Urgent claim or demand: *under the pressure of business; doesn't work well under pressure.* **7.** An oppressive condition of physical, mental, social, or economic distress. **8.** A physical sensation produced by compression of a part of the body. **9.** *Archaic.* A mark made by application of force or weight; an impression. **—pressure** *tr.v.* **-sured, -sur·ing, -sures.** **1.** To force, as by overpowering influence or persuasion. **2.** To pressurize. **3.** To pressure-cook. [Middle English, from Old French, from Latin *pressūra*, from *pressus*, past participle of *premere*, to press. See **per-**[4] in Appendix.]

pressure cabin *n.* A pressurized section of an aircraft.

pres·sure-cook (prĕsh′ər-kŏŏk′) *tr.v.* **-cooked, -cook·ing, -cooks.** To cook in a pressure cooker.

pressure cooker *n.* **1.** An airtight metal pot that uses steam under pressure at high temperature to cook food quickly. **2.** *Informal.* A situation or an atmosphere of difficulty, stress, or anxiety: *"placing children into social, educational pressure cookers"* (Fred M. Hechinger).

pressure gauge *n.* **1.** A device for measuring the pressure of a gas or liquid. **2.** A device for measuring the pressure of explosions.

pressure group *n.* An interest group that endeavors to influence public policy and especially governmental legislation regarding its particular concerns and priorities.

pressure point *n.* **1.** Any of several points on the body at which an underlying artery can be pressed against a bone to stop distal bleeding. **2.** An area on the skin that is highly sensitive to the application of pressure.

pressure suit *n.* A garment that is worn in high-altitude aircraft or in spacecraft to compensate for low-pressure conditions.

pres·sur·ize (prĕsh′ə-rīz′) *tr.v.* **-ized, -iz·ing, -iz·es.** **1.** To maintain normal air pressure in (an enclosure, as an aircraft or a submarine). **2.** To put (gas or liquid) under a greater than normal pressure. **3.** To design to resist pressure. **4.** To pressure-cook. **5.** *Informal.* To subject to excessive stress, strain, or vexation: *an executive who was pressurized by a heavy workload.* **—pres′sur·i·za′tion** (-ər-ĭ-zā′shən) *n.* **—pres′sur·iz′er** *n.*

press·work (prĕs′wûrk′) *n.* **1.** Management or operation of a printing press. **2.** The matter printed by such a press.

Pres·ter John (prĕs′tər jŏn′) *n.* A legendary medieval Christian priest and king thought to have reigned over a Christian kingdom in the Far East or Ethiopia. [Middle English *prester* priest, from Old French, from Late Latin *presbyter.* See PRIEST.]

pre·ster·num (prē-stûr′nəm) *n.* See **manubrium.**

pres·ti·dig·i·ta·tion (prĕs′tĭ-dĭj′ĭ-tā′shən) *n.* Manual skill and dexterity in the execution of tricks; sleight of hand. [French (influenced by *prestigiateur*, juggler, conjurer, from *prestige*, illusion; see PRESTIGE), from *prestidigitateur*, conjurer: *preste* (from Italian *presto*; see PRESTO) + Latin *digitus*, finger; see DIGIT.] **—pres′ti·dig′i·ta′tor** *n.*

pres·tige (prĕ-stēzh′, -stēj′) *n.* **1.** The level of respect in which one is regarded by others; standing. **2.** A person's high standing among others; honor or esteem. **3.** Widely recognized prominence, distinction, or importance: *a position of prestige in diplomatic circles.* **—*attributive.*** Often used to modify another noun: *a prestige address; the prestige groups in society.* [French, illusion, from Latin *praestīgiae*, tricks, probably alteration of **praestrīgiae*, from *praestringere*, to touch, blunt, blind; see pre- + *stringere*, to draw tight; see **streig-** in Appendix.]

pres·ti·gious (prĕ-stē′jəs, -stĭj′əs) *adj.* Having prestige; esteemed. **—pres·ti′gious·ly** *adv.* **—pres·ti′gious·ness** *n.*

pres·tis·si·mo (prĕ-stĭs′ə-mō′) *Music. adv. & adj.* In a tempo as possible. Used chiefly as a direction. **—presti·ssi·** *pl.* **-mos.** A prestissimo passage or movement. [Italian, lative of *presto*, presto. See PRESTO.]

pres·to (prĕs′tō) *adv.* **1.** *Music.* In a very fast tempo, considered to be faster than allegro but slower than prestissimo. Used chiefly as a direction. **2.** So suddenly that things happen involved; right away. **—presto** *n., pl.* **-tos.** *Music.* A passage or movement that is performed presto. [Italian, from Late Latin *praestus*, quick, from Latin *praestō*, at hand.] **—pres′to·** *adv.*

Pres·ton (prĕs′tən). A borough of northwest England, northeast of Liverpool. The Jacobites surrendered here after an uprising in 1715. Population, 125,800.

pre·sum·a·ble (prĭ-zōō′mə-bəl) *adj.* That can be presumed or taken for granted; reasonable as a supposition: *presumable causes of the disaster.* **—pre·sum′a·bly** *adv.*

pre·sume (prĭ-zōōm′) *v.* **-sumed, -sum·ing, -sumes.** **1.** To take for granted as being true in the absence of proof to the contrary. **2.** To give reasonable evidence for assuming; appear to prove. **3.** To venture without authority or permission; dare. *He presumed to invite himself to dinner.* — *intr.* **1.** To act overconfidently; take liberties. **2.** To take unwarranted advantage of

Old French : *re-*, re- + *aconter*, to count up, reckon; see ACCOUNT.]

ra·coon (ră-kōōn′) *n.* Variant of **raccoon.**

rac·quet (răk′ĭt) *n. Sports.* Variant of **racket**[1].

rac·quet·ball (răk′ĭt-bôl′) *n. Sports.* A game played on a four-walled handball court by two or four players with short-handled rackets and a hollow rubber ball 2¼ inches (5.7 centimeters) in diameter.

rac·quets also **rack·ets** (răk′ĭts) *pl.n. (used with a sing. verb). Sports.* A game played on a large, netless, four-walled court by two or four players with long-handled rackets and a hard, fast-moving ball 1 inch (2.5 centimeters) in diameter.

rac·y (rā′sē) *adj.* **-i·er, -i·est. 1.** Having a distinctive and characteristic quality or taste. **2.** Strong and sharp in flavor or odor; piquant or pungent. **3.** Risqué; ribald. **4.** Vigorous; lively. [From RACE[1].] **—rac′i·ly** *adv.* **—rac′i·ness** *n.*

rad[1] (răd) *n. Physics.* A unit of energy absorbed from ionizing radiation, equal to 100 ergs per gram or 0.01 joule per kilogram of irradiated material. [Short for RADIATION.]

rad[2] (răd) *adj. Slang.* **1.** Radical: *rad moves on a skateboard.* **2.** Wonderful; marvelous.

rad[3] *abbr. Mathematics.* Radian.

rad. *abbr.* **1.** *Mathematics.* Radical. **2.** Radio. **3.** *Mathematics.* Radius. **4.** *Mathematics.* Radix.

ra·dar (rā′där) *n.* **1.** A method of detecting distant objects and determining their position, velocity, or other characteristics by analysis of very high frequency radio waves reflected from their surfaces. **2.** The equipment used in such detection. *—attributive.* Often used to modify another noun: *radar technology; a radar installation.* [RA(DIO) + D(ETECTING) + A(ND) + R(ANGING).]

radar astronomy *n.* The branch of astronomy that studies bodies in the solar system by analyzing the reflections of radio waves sent from Earth.

radar beacon *n.* A fixed device that sends or receives, amplifies, alters, and returns a radar signal, permitting a distant receiver to determine its bearing and sometimes its range.

ra·dar·scope (rā′där-skōp′) *n.* The oscilloscope viewing screen of a radar receiver.

radar telescope *n.* A large radar antenna used in radar astronomy.

Rad·cliffe (răd′klĭf′), **Ann Ward.** 1764–1823. British writer of Gothic novels, including *The Mysteries of Udolpho* (1794).

rad·dle[1] (răd′l) *tr.v.* **-dled, -dling, -dles.** To twist together; interweave. [From dialectal *raddle*, stick interwoven with others in a fence, from Anglo-Norman *reidele*, stout pole, possibly from Middle High German *reidel*, rod. See **reidh-** in Appendix.]

rad·dle[2] (răd′l) *n. & v.* Variant of **ruddle.**

rad·dled (răd′ld) *adj.* Worn-out and broken-down. [Origin unknown.]

radi— *pref.* Variant of **radio—.**

ra·di·al (rā′dē-əl) *adj.* **1.a.** Of, relating to, or arranged like rays or radii. **b.** Radiating from or converging to a common center. **c.** Having or characterized by parts so arranged or so radiating. **2.** Moving or directed along a radius. **3.** *Anatomy.* Of, relating to, or near the radius or forearm. **4.** Developing symmetrically about a central point. **—radial** *n.* **1.** A radial part, such as a ray, spoke, or radius. **2.** A radial tire. [Middle English, from Medieval Latin *radiālis*, from Latin *radius*, ray.] **—ra′di·al·ly** *adv.*

radial engine *n.* An internal-combustion engine, formerly used in propeller-driven aircraft, with cylinders arranged radially around the crankshaft.

radially symmetrical *adj.* Having radial symmetry; actinomorphic.

radial symmetry *n.* Symmetrical arrangement of constituents, especially of radiating parts, about a central point.

radial tire *n.* A pneumatic tire in which the ply cords extending to beads are laid at approximately right angles to the center line of the tread.

ra·di·an (rā′dē-ən) *n.* Abbr. **rad** *Mathematics.* A unit of angular measure equal to the angle subtended at the center of a circle by an arc equal in length to the radius of the circle, approximately 57°17′44.6″. See table at **measurement.** [RADI(US) + **-AN**[1].]

ra·di·ance (rā′dē-əns) also **ra·di·an·cy** (-ən-sē) *n.* **1.** The quality or state of being radiant. **2.** *Physics.* The radiant energy emitted per unit time in a specified direction by a unit area of an emitting surface.

ra·di·ant (rā′dē-ənt) *adj.* **1.** Emitting heat or light. **2.** Consisting of or emitted as radiation: *radiant heat.* **3.a.** Filled with light; bright. **b.** Glowing; beaming. See Synonyms at **bright.** *—radiant n.* **1.** An object or a point from which light or heat rays are emitted. **2.** *Astronomy.* The apparent celestial origin of a meteoric shower. [Middle English, from Latin *radiāns, radiant-*, present participle of *radiāre*, to radiate. See RADIATE.] **—ra′di·ant·ly** *adv.*

radiant energy *n. Physics.* Energy transferred by radiation, especially by an electromagnetic wave.

radiant flux *n. Physics.* The rate of flow of radiant energy.

ra·di·ate (rā′dē-āt′) *v.* **-at·ed, -at·ing, -ates.** *—intr.* **1.** To send out rays or waves. **2.** To issue or emerge in rays or waves: *Heat radiated from the stove.* **3.** To extend in straight lines from or toward a center; diverge or converge like rays: *Spokes radiate from a wheel hub.* **4.** *Ecology.* To spread into new habitats and thereby diverge or diversify. Used of a group of organisms. *—tr.* **1.** To emit (light, for example) in or as if in rays. **2.** To send or spread out from or as if from a center: *a cactus that radiates spines.* **3.** To irradiate or illuminate (an object). **4.** To manifest in a glowing manner: *a leader who radiates confidence.* **—radiate** (-ĭt) *adj.* **1.** *Botany.* Having rays or raylike parts, as in the flower heads of daisies. **2.** *Biology.* Characterized by radial symmetry. **3.** Surrounded with rays: *a radiate head on a coin.* [Latin *radiāre, radiāt-*, to emit beams, from *radius*, ray.] **—ra′di·a·tive** *adj.*

ra·di·a·tion (rā′dē-ā′shən) *n.* **1.** The act or process of radiating: *the radiation of heat and light from a burning body.* **2.** *Physics.* **a.** Emission and propagation of energy in the form of rays or waves. **b.** Energy radiated or transmitted in the form of rays, waves, or particles. **c.** A stream of particles or electromagnetic waves emitted by the atoms and molecules of a radioactive substance as a result of nuclear decay. **3.** *Anatomy.* Radial arrangement of parts, as of a group of nerve fibers connecting different areas of the brain. **4.a.** *Ecology.* The spread of a group of organisms into new habitats. **b.** Adaptive radiation.

ra·di·a·tion·al cool·ing (rā′dē-ā′shə-nəl kōō′lĭng) *n.* The cooling of the earth's surface and the air near the surface, occurring chiefly at night and caused by heat loss engendered by terrestrial radiation.

radiation sickness *n.* Illness induced by ionizing radiation, ranging in severity from nausea, vomiting, headache, and diarrhea to loss of hair and teeth, reduction in red and white blood cell counts, extensive hemorrhaging, sterility, and death.

ra·di·a·tor (rā′dē-ā′tər) *n.* **1.** A heating device consisting of a series of connected pipes, typically inside an upright metal structure, through which steam or hot water is circulated so as to radiate heat into the surrounding space. **2.** A cooling device, as in automotive engines, through which water or other fluids circulate as a coolant. **3.** *Physics.* A body that emits radiation. **4.** A transmitting antenna.

rad·i·cal (răd′ĭ-kəl) *adj.* **1.** Arising from or going to a root or source; basic: *a radical flaw in a plan; chose the radical solution of starting all over again.* **2.** Departing markedly from the usual or customary; extreme: *radical opinions on education.* **3.** Favoring or effecting fundamental or revolutionary changes in current practices, conditions, or institutions: *radical political views.* **4.** *Linguistics.* Of or being a root: *a radical form.* **5.** *Botany.* Arising from the root or its crown: *radical leaves.* **—radical** *n.* **1.** One who advocates fundamental or revolutionary changes in current practices, conditions, or institutions: *radicals seeking to overthrow the social order.* **2.** *Abbr.* **rad.** *Mathematics.* The root of a quantity as indicated by the radical sign. **3.** *Symbol* R An atom or a group of atoms with at least one unpaired electron. **4.** Abbr. **rad.** *Linguistics.* See **root**[1] (sense 8). [Middle English, from Late Latin *rādīcālis*, having roots, from Latin *rādīx, rādīc-*, root. See **wrād-** in Appendix.] **—rad′i·cal·ly** *adv.* **—rad′i·cal·ness** *n.*

radical expression *n. Mathematics.* An expression in which radical signs appear.

rad·i·cal·ism (răd′ĭ-kə-lĭz′əm) *n.* **1.** The doctrines or practices of radicals. **2.** The quality of being radical.

rad·i·cal·ize (răd′ĭ-kə-līz′) *tr.v.* **-ized, -iz·ing, -iz·es.** To make radical or more radical: *"Many, probably most, of those have been radicalized by their experiences among the poor"* (Conor Cruise O'Brien). **—rad′i·cal·i·za′tion** (-kə-lĭ-zā′

radical sign *n. Mathematics.* **1.** The sign √ placed before a quantity, indicating extraction of the root designated by an integer. When extracting a square root, the raised integer is customarily omitted. **2.** The radical sign together with a horizontal bar extending from its top to the end of the expression from which a root is to be extracted.

rad·i·cand (răd′ĭ-kănd′) *n. Mathematics.* The quantity under a radical sign. For example, 3 is the radicand of √3. [Latin *rādīcandum*, neuter gerundive of *rādīcāre*, to take root, from *rādīx, rādīc-*, root. See RADICAL.]

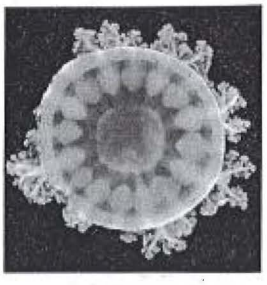
ra·dic·chi·o (rə-dē′kē-ō, rä-) *n., pl.* **-os.** Any of several prized varieties of chicory, having red or red-spotted leaves and form globose or elongated heads. [Italian, from Old Italian *ric* ory, from Vulgar Latin **rādīculum*, from Latin *rādīx*, utive of *rādīx, rādīc-*, root. See RADISH.]

rad·i·ces (răd′ĭ-sēz′, rā′dĭ-) *n.* A plural of **radix.**

rad·i·cle (răd′ĭ-kəl) *n.* **1.** *Botany.* The part of a plant that develops into a root. **2.** *Anatomy.* A small structure, as a fibril of a nerve, that resembles a root. [Latin *rādīcula*, utive of *rādīx, rādīc-*, root. See **wrād-** in Appendix.]

ra·di·i (rā′dē-ī′) *n.* A plural of **radius.**

ra·di·o (rā′dē-ō) *n., pl.* **-os.** *Abbr.* **rad. 1.** The transmission through space of electromagnetic waves of approximate frequency range from 10 kilohertz to 300,000 megahertz. **2.** Communication of audible signals encoded in electromagnetic waves. **3.** Transmission of programs for the public by radio broadcast. **4.a.** An apparatus used to transmit signals; a transmitter. **b.** An apparatus used to receive signals; a receiver. **c.** A complex of equipment capable of transmitting and receiving radio signals. **5.a.** A station for transmitting. **b.** A radio broadcasting organization and its affiliated organizations. **c.** The radio broadcasting industry. A message sent by radio. *—attributive.* Often used

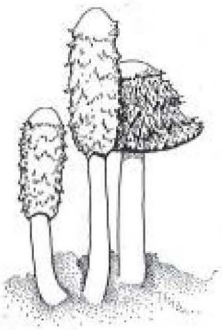


radial symmetry
Jellyfish

ă pat	oi boy
ā pay	ou out
âr care	o͝o took
ä father	o͞o boot
ĕ pet	ŭ cut
ē be	ûr urge
ĭ pit	th thin
ī pie	*th* this
îr pier	hw which
ŏ pot	zh vision
ō toe	ə about, item
ô paw	♦ regionalism

Stress marks: ′ (primary); ″ (secondary), as in **dictionary** (dĭk′shə-nĕr′ē)

shagbark
Carya ovata



shaggymane
Coprinus comatus

ă pat	oi boy
ā pay	ou out
âr care	o͝o took
ä father	o͞o boot
ĕ pet	ŭ cut
ē be	ûr urge
ĭ pit	th thin
ī pie	*th* this
îr pier	hw which
ŏ pot	zh vision
ō toe	ə about, item
ô paw	♦ regionalism

Stress marks: ˈ (primary); ˌ (secondary), as in **dictionary** (dĭkˈshə-nĕrˌē)

shaft (shăft) *n.* **1.a.** The long, narrow stem or body of a spear or an arrow. **b.** A spear or an arrow. **2.a.** A projectile suggestive of a spear or an arrow in appearance or configuration. **b.** *Informal.* A scornfully satirical comment; a barb. **c.** *Slang.* Harsh, unfair treatment. Often used with *the*: *The president of the airline really gave the unions the shaft.* **3.** A ray or beam of light. **4.** The handle of any of various tools or implements. **5.** The main axis of a feather, especially its distal portion. **6.** *Anatomy.* **a.** The midsection of a long bone; diaphysis. **b.** The section of a hair projecting from the surface of the body. **7.** *Architecture.* **a.** A column or an obelisk. **b.** The section of a column between the capital and the base. **8.** One of two parallel poles between which an animal is harnessed to a vehicle. **9.** A long, generally cylindrical bar, especially one that rotates and transmits power, as the drive shaft of an engine. **10.** A long, narrow, often vertical passage sunk into the earth, as for mining ore; a tunnel. **11.** A vertical passage housing an elevator. **12.** A duct or conduit for the passage of air, as for ventilation or heating. —**shaft** *tr.v.* **shaft·ed, shaft·ing, shafts.** **1.** To equip with a shaft. **2.** *Slang.* To treat in a harsh, unfair way: *"He had been shafted by the press quite a bit"* (Frank Deford). [Middle English, from Old English *sceaft.*]

Shaftes·bur·y (shăftsˈbĕrˈē, -bə-rē), First Earl of. Title of Anthony Ashley Cooper. 1621–1683. English politician. Originally a Royalist, he later opposed Charles II in the English Civil War and is considered the founder of the Whig Party.

shaft·ing (shăftˈĭng) *n.* **1.** A system of shafts, as in a mechanical device, for transmitting motion or power. **2.** Material from which shafts are made. **3.** *Slang.* An instance of harsh or unfair treatment: *got a shafting when they bought that house.*

shag[1] (shăg) *n.* **1.** A tangle or mass, especially of rough, matted hair. **2.a.** A coarse long nap, as on a woolen cloth. **b.** Cloth having such a nap. **3.** A rug with a thick, rough pile. **4.** Coarse shredded tobacco. —**shag** *tr.v.* **shagged, shag·ging, shags.** **1.** To make shaggy; roughen. **2.a.** To chase and bring back; fetch. **b.** *Baseball.* To chase and catch (fly balls) in practice. [Middle English **shagge*, from Old English *sceacga*, matted hair.]

shag[2] (shăg) *n.* A dance step of the 1930's consisting of a hop on each foot in turn. —**shag** *intr.v.* **shagged, shag·ging, shags.** To perform or execute this dance. [Origin unknown.]

shag[3] (shăg) *n.* Either of two marine birds *(Phalacrocorax aristotelis* or *P. punctatus)* of Europe and North Africa, related to the cormorant. [Perhaps from its shaggy crest.]

shag·bark (shăgˈbärkˈ) *n.* An eastern North American hickory tree *(Carya ovata)* having shaggy bark, pinnately compound leaves, and hard-shelled nuts with edible seeds. Also called *shellbark.*

shag·gy (shăgˈē) *adj.* **-gi·er, -gi·est.** **1.** Having, covered with, or resembling long rough hair or wool. **2.** Bushy and matted: *shaggy hair.* **3.** Having a rough nap or surface, as a textile. **4.** Poorly groomed; unkempt. **5.** Marked by a lack of order or clarity in thinking, planning, or performance. —**shag′gi·ly** *adv.* —**shag′gi·ness** *n.*

shaggy cap *n.* See **shaggymane.**

shag·gy-dog story (shăgˈē-dôgˈ, -dŏgˈ) *n. Informal.* A long, drawn-out anecdote ending with an absurd or anticlimactic punch line.

shag·gy·mane also **shag·gy mane** (shăgˈē-mānˈ) *n.* An edible inky cap mushroom *(Coprinus comatus)* having shaggy scales covering the cap. Also called *shaggy cap.*

sha·green (shə-grēnˈ) *n.* **1.** The rough hide of a shark or ray, covered with numerous bony denticles and used as an abrasive and as leather. **2.** An untanned leather with a granular surface that is often dyed green. [French *chagrin, sagrin,* from Turkish *sağri,* crupper, leather.] —**sha·greenˈ** *adj.*

shah (shä) *n.* Used formerly as a title for the hereditary monarch of Iran. [Persian *shāh,* king, from Old Persian *khshāyathiya-.*] —**shahˈdom** *n.*

Sha·hap·ti·an (shä-hăpˈtē-ən) *n.* Variant of **Sahaptian.**

Sha·hap·tin (shä-hăpˈtĭn) *n.* Variant of **Sahaptin.**

Shah Ja·han (shäˈ jə-hänˈ). 1592–1666. Mogul emperor of India (1628–1658) whose reign ushered in the golden age of Mogul art and architecture. The Taj Mahal was built at his request as a memorial to his favorite wife.

Shahn (shän), **Benjamin.** Known as "Ben." 1898–1969. Lithuanian-born American artist whose works, such as *The Passion of Sacco and Vanzetti* (1931–1932), reflect social and political themes.

shai·tan (shī-tänˈ, shä-) *n.* **1.** Often **Shaitan.** *Islam.* The Devil; Satan. **2.** An evil spirit; a fiend. [Arabic *šayṭān,* from Hebrew *śāṭān.* See SATAN.]

shake (shāk) *v.* **shook** (sho͝ok), **shak·en** (shāˈkən), **shaking, shakes.** —*tr.* **1.** To cause to move to and fro with jerky movements. **2.** To cause to quiver, tremble, vibrate, or rock. **3.** To cause to lose stability or waver: *a crisis that shook my deepest beliefs.* **4.** To remove or dislodge by jerky movements: *shook the dust from the cushions.* **5.a.** To bring to a specified condition by or as if by shaking: *"It is not easy to shake one's heart free of the impression"* (John Middleton Murry). **b.** *Slang.* To get rid of: *couldn't shake the man who was following us.* **6.** To disturb or agitate; unnerve: *She was shaken by the news of the disaster.* **7.** To brandish or wave, especially in anger: *shake one's fist.* **8.** To clasp (hands) in greeting or leave-taking or as a sign of agreement. **9.** *Music.* To trill (a note). **10.** *Games.* To rattle and mix (dice) before casting. —*intr.* **1.** To move to and fro in short, irregular, often jerky movements. **2.** To tremble, as from cold or in anger. **3.** To be unsteady; totter or waver. **4.** To move something vigorously up and down or from side to side, as in mixing. **5.** *Music.* To trill. **6.** To shake hands: *Let's shake on it.* —**shake** *n.* **1.** The act of shaking. **2.** A trembling or quivering movement. **3.** *Informal.* An earthquake. **4.a.** A fissure in rock. **b.** A crack in timber caused by wind or frost. **5.** *Informal.* A moment or an instant; a trice: *I'll do it in a shake.* **6.** *Music.* A trill. **7.a.** See **milk shake** (sense 1). **b.** A beverage in which the ingredients are mixed by shaking. **8.** A rough shingle used to cover rustic buildings, such as barns: *cedar shakes.* **9. shakes.** *Informal.* Uncontrollable trembling, as in a person who is cold, frightened, feverish, or ill. Often used with *the*: *was suffering from a bad case of the shakes.* **10.** *Slang.* A bargain or deal: *getting a fair shake.* —***phrasal verbs.*** **shake down.** **1.** *Slang.* To extort money from. **2.** *Slang.* To make a thorough search of: *shook down the prisoners' cells for hidden weapons.* **3.** To subject (a new ship or aircraft) to shakedown testing. **4.** To become acclimated or accustomed, as to a new environment or a new job. **shake off.** To free oneself of; get rid of: *We shook off our fears.* **shake up.** **1.** To upset by or as if by a physical jolt or shock: *was badly shaken up by the accident.* **2.** To subject to a drastic rearrangement or reorganization: *new management bent on shaking up the company.* —***idioms.*** **give (someone) the shake.** *Slang.* To escape from or get rid of: *We managed to give our pursuers the shake.* **no great shakes.** *Slang.* Unexceptional; ordinary: *"stepping in between the victim and the bully, even when the victim happens to be no great shakes"* (Louis Auchincloss). **shake a leg.** *Informal.* To dance. **2.** To move quickly; hurry up. **shake (another's) tree.** *Slang.* To arouse to action or reaction; disturb: *"[He] so shook Hollywood's tree that . . . all manner of . . . people called me unsolicited to itemize his mistakes or praise his courage"* (Tina Brown). **shake a stick at.** *Slang.* To point out, designate, or name: *"All of a sudden there came into being a vast conservative infrastructure: think-tanks . . . and more foundations than you could shake a stick at"* (National Review). [Middle English *shaken,* from Old English *sceacan.*] —**shakˈa·ble, shakeˈa·ble** *adj.*

SYNONYMS: *shake, tremble, quake, quiver, shiver, shudder.* These verbs mean to manifest involuntary vibratory movement. *Shake* is the most general: *The child's small body shook with weeping. The floor shook when she walked across the room. Tremble* implies quick, rather slight movement, as from excitement, weakness, or anger: *I could feel the youngster's hand tremble in mine. The apple blossoms trembled in the wind. Quake* refers to more violent movement, as that caused by shock or upheaval: *I was so terrified that my legs began to quake. Quiver* suggests a slight, rapid, tremulous movement: *"Her lip quivered like that of a child about to cry"* (Booth Tarkington). *Shiver* involves rapid, rather slight trembling, as of a person experiencing chill: *"a cold hoary winter night stood shivering in the snow"* (Robert Southwell). *Shudder* applies chiefly to convulsive shaking caused by fear, horror, or revulsion: *"She starts like one that spies an adder / . . . The fear whereof doth make him shake and shudder"* (Shakespeare). See also Synonyms at **agitate, dismay.**

shake·down (shākˈdounˈ) *n.* **1.** *Slang.* Extortion of money, as by blackmail. **2.** *Slang.* A thorough search of a place or person. **3.** A period of appraisal followed by adjustments to improve efficiency or functioning. —**shakedown** *adj.* Serving to test the performance of a ship or an aircraft and to familiarize the crew with operation of the craft: *a shakedown cruise; a shakedown flight.*

WORD HISTORY: In 1969 a majority of the members of the *American Heritage Dictionary* Usage Panel felt that the noun *shakedown* in the sense "extortion" and the related phrasal verb *shake down* were acceptable in writing, though both are now labeled *slang.* It would seem that certain usages take a while to attain respectability because of the company they keep. Shake and the verb phrase *shake out of* already meant "to steal" in Middle English. This usage of *shake* is still found in the 19th and 20th centuries. Both *shake* and *shake out of* in the sense "to steal" are clearly related to *shake down,* which is first recorded in 1672, *shake down* being glossed "to extort money from individuals." This is a slang usage, probably occurring, as had the verb *shake* largely in contexts having to do with criminal or corrupt behavior. As our Panel realized, the verb and the later noun *shakedown* (first recorded in 1902 in the United States) have now moved from the lingo of criminals, loan sharks, and politicians into wider currency.

shak·en (shāˈkən) *v.* Past participle of **shake.**

shake·out (shākˈoutˈ) *n.* **1.** The elimination of companies, businesses or products in a particular field. **2.** A decline in the values of certain securities that usually results in a depressed stock market.

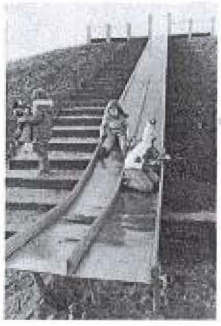
shak·er (shāˈkər) *n.* **1.a.** One that shakes: *a shaker of long-held beliefs and traditions.* **b.** One that impels, encourages, or supervises action. **2.a.** A container used for shaking: *salt and pepper shakers.* **b.** A container used to mix or blend by shaking: *a cocktail shaker.* **3. Shaker.** A member of a Christian group originating in England in 1747, practicing communal living and observing celibacy. —**shaker** also **Shaker** *adj.* Relating

sleep·y·head (slēʹpē-hĕdʹ) *n. Informal.* A sleepy person.
sleepy sickness *n.* See **encephalitis lethargica.**
sleet (slēt) *n.* **1.** Precipitation consisting of generally transparent frozen or partially frozen raindrops. **2.** A mixture of rain and snow or hail. **3.** A thin icy coating that forms when rain or sleet freezes, as on trees or streets. **—sleet** *intr.v.* **sleet·ed, sleet·ing, sleets.** To shower sleet. [Middle English *slete,* from Old English **slēte.*] **—sleetʹy** *adj.*
sleeve (slēv) *n.* **1.** A part of a garment that covers all or part of an arm. **2.** A case into which an object or a device fits: *a record sleeve.* **—sleeve** *tr.v.* **sleeved, sleev·ing, sleeves.** To furnish or fit with sleeves or a sleeve. **—*idiom.* up (one's) sleeve.** Hidden but ready to be used: *I still have a few tricks up my sleeve.* [Middle English *sleve,* from Old English *slēf.* See **sleubh-** in Appendix.] **—sleeveʹless** *adj.*
sleeve coupling *n.* A thin steel cylinder joining the ends of two lengths of shafting or pipe.
sleeve dog *n.* A very small Pekingese, usually 15 centimeters (6 inches) or less in height.


sleigh

sleigh (slā) *n.* A light vehicle mounted on runners and having one or more seats, usually drawn by a horse over snow or ice. **—sleigh** *intr.v.* **sleighed, sleigh·ing, sleighs.** To ride in or drive a sleigh. [Dutch *slee,* variant of *slede,* from Middle Dutch *slēde.*] **—sleighʹer** *n.*
sleight (slīt) *n.* **1.** Deftness; dexterity. **2.** A clever or skillful trick or deception; an artifice or a stratagem. [Middle English, alteration of *sleahthe,* from Old Norse *slægdh,* from *slœgr,* sly.]
sleight of hand *n., pl.* **sleights of hand. 1.** A trick or set of tricks performed by a juggler or magician so quickly that the manner of execution cannot be observed; legerdemain. **2.** Performance of conjuring tricks. **3.** Skill in performing conjuring tricks.
slen·der (slĕnʹdər) *adj.* **-er, -est. 1.a.** Having little width in proportion to height or length; long and thin: *a slender rod.* **b.** Thin and delicate in build; gracefully slim: *"She was slender as a willow shoot is slender—and equally graceful, equally erect"* (Frank Norris). **2.** Small in amount or extent; meager: *slender wages; a slender chance of survival.* [Middle English *sclendre, slendre.*] **—slenʹder·ly** *adv.* **—slenʹder·ness** *n.*
slen·der·ize (slĕnʹdə-rīzʹ) *tr. & intr.v.* **-ized, -iz·ing, -iz·es.** To make or become slender or more slender.
slender loris *n.* A very small, tailless loris *(Loris gracilis)* of southern India and Srī Lanka, having large eyes with dark circles around them and very short fingers and toes.
slept (slĕpt) *v.* Past tense and past participle of **sleep.**
sleuth (slōōth) *n.* **1.** A detective. **2.** See **sleuthhound** (sense 1). **—sleuth** *v.* **sleuthed, sleuth·ing, sleuths.** *—tr.* To track or follow. *—intr.* To act as a detective. [Short for SLEUTHHOUND.]

WORD HISTORY: To track down the history of the word *sleuth* requires a bit of etymological sleuthing in itself. The immediate ancestor of our word is the compound *sleuthhound,* "a dog, such as a bloodhound, used for tracking or pursuing." This term took on a figurative sense, "tracker, pursuer," which is closely related to the sense "detective." From *sleuthhound* came the shortened form *sleuth,* recorded in the sense "detective" as early as 1872. The first part of the term *sleuthhound* means "track, path, trail," and is first recorded in a Middle English work written probably around 1200. The Middle English word, which had the form *sloth,* with *eu* representing the Scots development of the Middle English (ō), was a borrowing of the Old Norse word *slōdh,* "a track or trail."


slide

sleuth·hound (slōōthʹhoundʹ) *n.* **1.** A dog used for tracking or pursuing, such as a bloodhound. Also called *sleuth.* **2.** A detective. [Middle English *sleuth,* animal track (from Old Norse *slōdh*) + HOUND.]
slew[1] also **slue** (slōō) *n. Informal.* A large amount or number; a lot: *a slew of unpaid bills.* [Irish Gaelic *sluagh,* multitude, from Old Irish *slúag.*]
slew[2] (slōō) *v.* Past tense of **slay.**
slew[3] (slōō) *n.* Variant of **slough**[1].
slew[4] (slōō) *v. & n.* Variant of **slue**[1].
slice (slīs) *n.* **1.** A thin, broad piece cut from a larger amount. **2.** A portion or share: *a slice of the profits.* **3.a.** A knife with a broad, thin, flexible blade, used for cutting and serving food. **b.** A similar implement for spreading printing ink. **4.** *Sports.* **a.** A stroke that causes a ball to curve off course to the right or, if the player is left-handed, to the left. **b.** The course followed by such a ball. **—slice** *v.* **sliced, slic·ing, slic·es.** *—tr.* **1.** To cut or divide into slices: *slice a loaf of bread.* **2.** To cut from a larger piece: *slice off a piece of salami.* **3.** To cut through or across with or as if with a knife: *The harvester sliced the field.* **4.** To divide into portions or shares; parcel out. **5.** To spread, work at, or clear away with a bladed tool such as a slice bar. **6.** *Sports.* To hit (a ball) with a slice. *—intr.* **1.** To move like a knife: *The destroyer sliced through the water.* **2.** *Sports.* To hit a ball with a slice. [Middle English, splinter, from Old French *esclice,* from *esclicier,* to splinter, of Germanic origin.] **—slicʹa·ble** *adj.* **—slicʹer** *n.*
slice bar *n.* An iron tool with a broad flat end, used to loosen and clear out clinkers from furnace grates.
slice of life *n., pl.* **slices of life.** An episode of actual experience represented realistically and with little alteration in a dramatic, fictional, or reportorial work. **—sliceʹ-of-lifeʹ** (slīsʹ-ə-līfʹ) *adj.*
slick (slĭk) *adj.* **slick·er, slick·est. 1.** Smooth, glossy, and [illegible] pery: *sidewalks slick with ice.* See Synonyms at **sleek. 2.** [illegible] executed; adroit: *"as slick as a sonnet, but as dull as ditch water"* (Tallulah Bankhead). **3.** Shrewd; wily. **4.** Superficially attractive or plausible but lacking depth or soundness; glib: *a slick [illegible] ing style.* See Synonyms at **glib. —slick** *n.* **1.** A smooth or [illegible] pery surface or area. **2.a.** A floating film of oil. **b.** A trail [illegible] floating material: *a garbage slick.* **3.** An implement used to [illegible] a surface slick, especially a chisel used for smoothing and polishing. **4.** *Informal.* A magazine, usually of large popular readership, printed on high-quality glossy paper. **5.** A racing automobile tire with a smooth tread. **6.** *Slang.* An unarmed military aircraft, such as a spotter plane or helicopter. **—slick** *v.* **slicked, slick·ing, slicks. 1.** To make smooth, glossy, or oily. **2.** *Informal.* To make neat, trim, or tidy: *slicked themselves up for the camera.* [Middle English *slike,* from Old English **slicu.* See **lei-** in Appendix.] **—slickʹly** *adv.* **—slickʹness** *n.*
slick·en (slĭkʹən) *tr. & intr.v.* **-ened, -en·ing, -ens.** To [illegible] or become slick. **—slickʹen·er** *n.*
slick·en·side (slĭkʹən-sīdʹ) *n.* A polished, striated rock face caused by one rock mass sliding over another in a fault plane. [Dialectal *slicken,* glossy (alteration of SLICK) + SIDE.]
slick·er (slĭkʹər) *n.* **1.a.** A long water-repellant coat [illegible] made of oilskin. **b.** A raincoat made of a glossy or shiny material such as plastic or rubber. **2.** A tool for dressing hides. **3.** *Informal.* A cheat; a swindler. **4.** *Informal.* A person with [illegible] clothing and manners.
slid (slĭd) *v.* Past tense and past participle of **slide.**
slid·den (slĭdʹn) *v. Archaic.* A past participle of **slide.**
slide (slīd) *v.* **slid** (slĭd), **slid·ing, slides.** *—intr.* **1.** To [illegible] over a surface while maintaining smooth, continuous contact. **2.** To coast on a slippery surface, such as ice or snow. **3.** To [illegible] smoothly and quietly; glide: *slid past the door without [illegible] noticing.* **4.** To go unattended or unacted upon: *Let the matter slide.* **5.** To lose a secure footing or positioning; shift out of place; slip: *slid on the ice and fell.* **6.a.** To move downward: *Prices began to slide.* **b.** To return to a less favorable or less [illegible] condition. **7.** *Baseball.* To drop down and skid, usually feet first, into a base to avoid being put out. *—tr.* To cause to slide or [illegible] **—slide** *n.* **1.** A sliding movement or action. **2.** A smooth surface or track for sliding, usually inclined: *a water slide.* **3.** A playground apparatus for children to slide on, typically consisting of a smooth chute mounted by means of a ladder. **4.** A part that operates by sliding, as the U-shaped section of tube on a trombone that is moved to produce various tones. **5.** An image on a transparent base for projection on a screen. **6.** A small glass plate for mounting specimens to be examined under a microscope. **7.** The fall of a mass of rock, earth, or snow down a slope; an avalanche or a landslide. **8.** *Music.* **a.** A slight portamento used in [illegible] playing, passing quickly from one note to another. **b.** An ornamentation consisting of two grace notes approaching the [illegible] note. [Middle English *sliden,* from Old English *slīdan.*]

SYNONYMS: *slide, slip, glide, coast, skid, slither.* These [illegible] mean to move smoothly and continuously over or as if over a [illegible] pery surface. *Slide* usually implies rapid, easy movement with [illegible] loss of contact with the surface: *coal sliding down a chute; [illegible] drops sliding from a lifted oar"* (Theodore Roethke). *Slip* can [illegible] to smooth, easy, and quiet passage: *"the jackals . . . slipping [illegible] to the hills"* (Lord Dunsany). More often, however, the term is applied to accidental sliding resulting in loss of balance or [illegible] hold: *slipped on a patch of ice and sprained his ankle. Glide* [illegible] to smooth, free-flowing, seemingly effortless movement: *[illegible] snakes gliding up and down a hollow"* (Ralph Waldo Emerson); *[illegible] submarine glided silently through the water. Coast* applies especially to downward movement resulting from the effects of gravity or momentum: *The driver turned off the engine and let the car coast down the incline. Skid* implies an uncontrolled, often [illegible] ways sliding caused by a lack of traction: *The bus skidded [illegible] pavement. Slither* can mean to slip and slide, as on an [illegible] surface, often with friction and noise: *"The detached [illegible] slithered down the rock face for a moment and then made [illegible] ther sound"* (H.G. Wells). The word can also suggest the sinuous gliding motion of a reptile: *An iguana slithered across the [illegible]*

Sli·dell (slī-dĕlʹ). A city of southeast Louisiana northeast of New Orleans. It is primarily residential. Population, 26,71[illegible]
slid·er (slīʹdər) *n.* **1.** One that slides: *The snowy hill was [illegible] with young sliders.* **2.** *Baseball.* A fast pitch that breaks in the same direction as a curve ball at the last moment.
slide rule *n.* A device consisting of two logarithmically [illegible] rules mounted to slide along each other so that multiplication, division, and other more complex computations are reduced to the mechanical equivalent of addition or subtraction.
slide valve *n.* A valve that slides back and forth over [illegible] especially one in the cylinder wall of a steam engine that [illegible] the intake and outflow of steam to move the piston.
slid·ing scale (slīʹdĭng) *n.* A scale in which indicated [illegible] taxes, or wages vary in accordance with another factor, as [illegible] with the cost-of-living index or medical charges with a patient's income.
sli·er (slīʹər) *adj.* A comparative of **sly.**

above the water on stilts, and the name was then used for the mainland area. Dominated by Spain after the 16th century, Venezuela was liberated by Simón Bolívar in 1821, although it was not formally separated from Colombia until 1830. Caracas is the capital and the largest city. Population, 14,515,885. —**Ven'e·zue'lan** *adj. & n.*

Venezuela, Gulf of. An inlet of the Caribbean Sea between northwest Venezuela and northern Colombia. It extends southward as Lake Maracaibo.

venge (věnj) *tr.v.* **venged, veng·ing, veng·es.** *Archaic.* To avenge. [Middle English *vengen*, from Old French *vengier*. See VENGEANCE.]

ven·geance (věn'jəns) *n.* Infliction of punishment in return for a wrong committed; retribution: *"Something of vengeance I had tasted for the first time. An aromatic wine it seemed"* (Charlotte Brontë). —***idiom.* with a vengeance.** **1.** With great violence or force. **2.** To an extreme degree: *December has turned cold with a vengeance.* [Middle English, from Old French, from *vengier*, to avenge, from Latin *vindicāre*. See VINDICATE.]

venge·ful (věnj'fəl) *adj.* **1.** Desiring vengeance; vindictive. See Synonyms at **vindictive.** **2.** Indicating or proceeding from a desire for revenge. **3.** Serving to exact vengeance. —**venge'ful·ly** *adv.* —**venge'ful·ness** *n.*

V-en·gine (vē'ěn'jən) *n.* An internal-combustion engine having cylinders arranged so that pairs form V shapes.

veni— *pref.* Variant of **veno—.**

ve·ni·al (vē'nē-əl, vēn'yəl) *adj.* **1.** Easily excused or forgiven; pardonable: *a venial offense.* **2.** *Roman Catholic Church.* Minor, therefore warranting only temporal punishment. [Middle English, from Old French, from Late Latin *venialis*, from Latin *venia*, forgiveness. See **wen-**[1] in Appendix.] —**ve'ni·al'i·ty** (vē'nē-ăl'ĭ-tē, vēn-yăl'-), **ve'ni·al·ness** (vē'nē-əl-nĭs, vēn'yəl-) *n.* —**ve'ni·al·ly** *adv.*

venial sin *n. Roman Catholic Church.* An offense that is judged to be minor or committed without deliberate intent and thus does not estrange the soul from the grace of God.

Ven·ice (věn'ĭs). A city of northeast Italy on islets within a lagoon in the **Gulf of Venice,** a wide inlet of the northern Adriatic Sea. Founded in the 5th century A.D. by refugees fleeing the Lombard invaders who had gained control of the mainland, it became a major maritime power by the 13th century and spread its influence over northern Italy by the 15th century. Its territories were gradually lost to the Turks, and in 1797 it passed to Austria. Venice was ceded to Italy in 1866. Population, 332,775.

ven·in (věn'ĭn, vē'nĭn) also **ve·nene** (və-nēn', vēn'ēn) *n.* Any of various toxic substances found in the venom of snakes. [VEN(OM) + —IN.]

ve·ni·punc·ture also **ve·ne·punc·ture** (vē'nĭ-pŭngk'chər, vēn'ĭ-) *n.* Puncture of a vein, as for drawing blood, intravenous feeding, or administration of medicine.

ve·ni·re (və-nī'rē, -nīr'ē) *n. Law.* **1.** A writ issued by a judge to a sheriff directing the summons of prospective jurors. Also called *venire facias.* **2.** The panel of prospective jurors from which a jury is selected. [Short for Middle English *venire facias*, from Medieval Latin *venīre (faciās)*, (you should cause) to come, a phrase used in the writ, from Latin. See **g^{w}ā-** in Appendix.]

venire fa·ci·as (fā'shē-əs, -ăs') *n. Law.* See **venire** (sense 1). [Middle English. See VENIRE.]

ve·ni·re·man (və-nī'rē-mən, -nīr'ē-) *n. Law.* A person summoned to jury duty under a venire.

ven·i·son (věn'ĭ-sən, -zən) *n.* **1.** The flesh of a deer used as food. **2.** *Archaic.* The flesh of a game animal used as food. [Middle English *veneson*, from Old French, from Latin *vēnātiō, vēnātiōn-*, hunting, from *vēnātus*, past participle of *vēnārī*, to hunt. See **wen-**[1] in Appendix.]

Venn diagram (věn) *n.* A diagram using circles to represent an operation in set theory, with the position and overlap of the circles indicating the relationships between the sets. [After John *Venn* (1834–1923), British logician.]

veno— or **veni—** or **ven—** *pref.* Vein: *venipuncture.* [From Latin *vēna.*]

ve·no·gram (vē'nə-grăm') *n.* A radiograph of a vein after injection of a radiopaque substance.

ve·nog·ra·phy (vĭ-nŏg'rə-fē) *n.* Radiography of veins or a vein after injection of a radiopaque substance. Also called *phlebography.*

ven·om (věn'əm) *n.* **1.** A poisonous secretion of an animal, such as a snake, spider, or scorpion, usually transmitted by a bite or sting. **2.** A poison. **3.** Malice; spite. [Middle English *venim*, from Old French, from Vulgar Latin **venīmen*, from Latin *venēnum*, poison. See **wen-**[1] in Appendix.]

ven·om·ous (věn'ə-məs) *adj.* **1.a.** Secreting and transmitting venom: *a venomous snake.* **b.** Full of or containing venom. **2.** Malicious; spiteful: *a venomous remark.* See Synonyms at **poisonous.** —**ven'om·ous·ly** *adv.* —**ven'om·ous·ness** *n.*

ve·nose (vē'nōs') *adj.* **1.** Having noticeable veins or veinlike markings. **2.** Venous. [Latin *vēnōsus*, from *vēna*, vein.]

ve·nos·i·ty (vē-nŏs'ĭ-tē) *n.* The quality or condition of being venous or venose.

ve·nous (vē'nəs) *adj.* **1.** *Physiology.* Of or contained in the veins: *venous blood; venous circulation.* **2.** Having numerous veins, as a leaf or the wings of an insect. [From Latin *vēnōsus*, from *vēna*, vein.] —**ve'nous·ly** *adv.* —**ve'nous·ness** *n.*

vent[1] (vĕnt) *n.* **1.** A means of escape or release from confinement; an outlet: *give vent to one's anger.* **2.** An opening permitting the escape of fumes, a liquid, a gas, or steam. **3.** The small hole at the breech of a gun through which the charge is ignited. **4.** *Zoology.* The excretory opening of the digestive tract in animals such as birds, reptiles, amphibians, and fish. **5.** *Geology.* **a.** The opening of a volcano in the earth's crust. **b.** An opening on the ocean floor that emits hot water and dissolved minerals. —**vent** *tr.v.* **vent·ed, vent·ing, vents. 1.** To give often forceful expression or utterance to. **2.** To release or discharge (steam, for example) through an opening. **3.** To provide with a vent. [Partly from French *vent* (from Old French) and partly alteration of French *évent* (from Old French *esvent*, from *esventer*, to let out air, from Vulgar Latin **exventāre* : Latin *ex-*; see EX— + Latin *ventus*, wind; see **wē-** in Appendix).] —**vent'er** *n.*

SYNONYMS: *vent, express, utter, voice, air.* These verbs mean to give outlet to thoughts or emotions. To *vent* is to unburden oneself of a strong pent-up emotion: *"She was jealous . . . and glad of any excuse to vent her pique"* (Edward G.E.L. Bulwer-Lytton). *Express*, a more comprehensive term, refers to communication both by verbal and by nonverbal means: *can't express the idea adequately in words; expressed her affection with a hug; "expressing emotion in the form of art"* (T.S. Eliot). *Utter* involves vocal expression; it may imply speech but can also refer to inarticulate sounds: *"The words were uttered in the hearing of Montezuma"* (William Hickling Prescott). *"The Canon uttered a resounding sigh"* (John Galsworthy). *Voice* denotes the expression in speech or writing of the outlook or viewpoint of a person or, often, of a group: *The judge voiced her satisfaction that the jury had reached a verdict. The majority leader rose to voice the party's opposition to the bill.* To *air* is to give vent to and often to show off one's feelings, beliefs, or ideas: *He wants a forum where he can air his favorite theory.*

vent[2] (vĕnt) *n.* A slit in a garment, as in the back seam of a pocket. [Middle English *vente*, alteration (probably influenced by Old French *vent*, wind) of *fente*, from Old French, slit, from *fendre*, to split open, from Latin *findere*. See FISSION.]

vent·age (vĕn'tĭj) *n.* A small opening; a vent.

ven·tail (vĕn'tāl') *n.* The lower movable part of the front of a medieval helmet, fitting over the mouth or neck. [Middle English, from Old French *vantail*, from *vent*, wind, from Latin *ventus*. See **wē-** in Appendix.]

ven·ter (vĕn'tər) *n.* **1.** *Anatomy.* **a.** The abdomen. **b.** The prominent fleshy portion of a muscle. **c.** A cavity or hollowed surface, especially of a bone. **2.** *Zoology.* A part in lower forms of animal life corresponding to the abdomen of mammals. **3.** *Botany.* The swollen lower portion of an archegonium containing the egg. **4.** *Law.* The uterus of a woman as the source of offspring. [Anglo-Norman, from Latin.]

ven·ti·fact (vĕn'tə-făkt') *n.* A stone that has been shaped, polished, or faceted by wind-driven sand. [Latin *ventus*, wind; see VENT[1] + (ART)FACT.]

ven·ti·late (vĕn'tl-āt') *tr.v.* **-lat·ed, -lat·ing, -lates. 1.** To admit fresh air into (a mine, for example) to replace stale or noxious air. **2.** To circulate through and freshen: *A sea breeze ventilated the rooms.* **3.** To provide with a vent, as for airing. **4.** To expose (a substance) to the circulation of fresh air, as to retard spoilage. **5.** To expose to public discussion or examination: *The students ventilated their grievances.* **6.** To aerate or oxygenate (blood). [Middle English *ventilaten*, to blow away, from Latin *ventilāre, ventilāt-*, to fan, from *ventulus*, diminutive of *ventus*, wind. See **wē-** in Appendix.] —**ven'ti·la'tion** *n.*

ven·ti·la·tor (vĕn'tl-ā'tər) *n.* **1.** A device that circulates fresh air and expels stale or foul air. **2.** *Medicine.* A respirator. —**ven'ti·la·to'ry** (vĕn'tl-ə-tôr'ē, -tōr'ē) *adj.*

ventr— *pref.* Variant of **ventro—.**

ven·trad (vĕn'trăd) *adv.* Toward the ventral side or surface.

ven·tral (vĕn'trəl) *adj.* **1.** *Anatomy.* **a.** Relating to or situated on or close to the abdomen; abdominal. **b.** Relating to or situated on or close to the anterior aspect of the human body or the lower surface of the body of an animal. **2.** *Botany.* Of or on the lower or inner surface of an organ that faces the axis; adaxial. —**ventral** *n.* **1.** A ventral fin. **2.** The abdominal segment of an insect. [Late Latin *ventrālis*, from Latin *venter, ventr-*, belly.] —**ven'tral·ly** *adv.*

ventral fin *n. Zoology.* A fin, such as a pelvic fin or an anal fin, that is found on the ventral side of a fish.

ventral root *n.* The part of a spinal nerve, consisting of motor fibers, that arises from the anterior section of the spinal cord.

ven·tri·cle (vĕn'trĭ-kəl) *n.* **a.** A small cavity or chamber within a body or an organ, especially: **a.** The chamber on the left side of the heart that receives arterial blood from the left atrium and contracts to force it into the aorta. **b.** The chamber on the right side of the heart that receives venous blood from the right atrium and forces it into the pulmonary artery. **c.** Any of the interconnecting cavities of the brain. [Middle English, from Old French *ventricule*, from Latin *ventriculus*, diminutive of *venter*, belly.]

ven·tri·cose (vĕn'trĭ-kōs') also **ven·tri·cous** (-kəs) *adj.* Inflated, swollen, or distended, especially on one side: *the ventricose gullet of an insect.* [New Latin *ventricōsus*, from Latin *venter, ventr-*, belly.] —**ven'tri·cos'i·ty** (-kŏs'ĭ-tē) *n.*

ă pat	oi boy
ā pay	ou out
âr care	o͝o took
ä father	o͞o boot
ĕ pet	ŭ cut
ē be	ûr urge
ĭ pit	th thin
ī pie	*th* this
îr pier	hw which
ŏ pot	zh vision
ō toe	ə about, item
ô paw	◆ regionalism

Stress marks: ' (primary); ' (secondary), as in **dictionary** (dĭk'shə-nĕr'ē)

EXHIBIT 3

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(54) **SPRAY FOR FLUENT MATERIALS**

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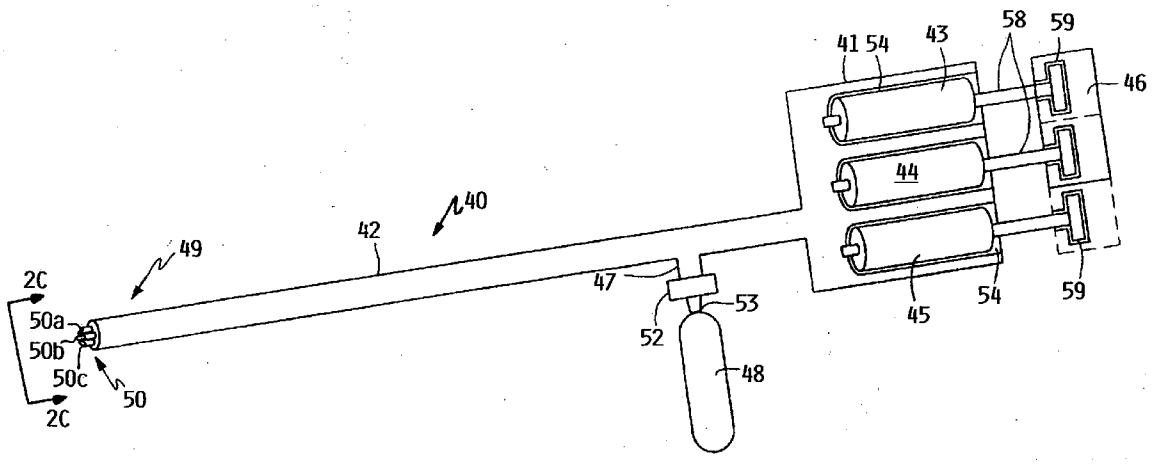
(57) **ABSTRACT**

Certain embodiments relate to a sprayer or other medical apparatus for applying a biocompatible coating in situ. Such an apparatus may have a first conduit connected to a first exit opening and a second conduit connected to a second exit opening to deliver a first composition through the first conduit and a second composition through the second conduit to mix the first composition and the second composition outside both the first conduit and the second conduit. The first composition may be, e.g., a precursor to a material formed after the mixing of the first composition and the second composition. The first exit opening and the second exit opening may be approximately adjacent to each other and define an angle that is less than about 140 degrees.



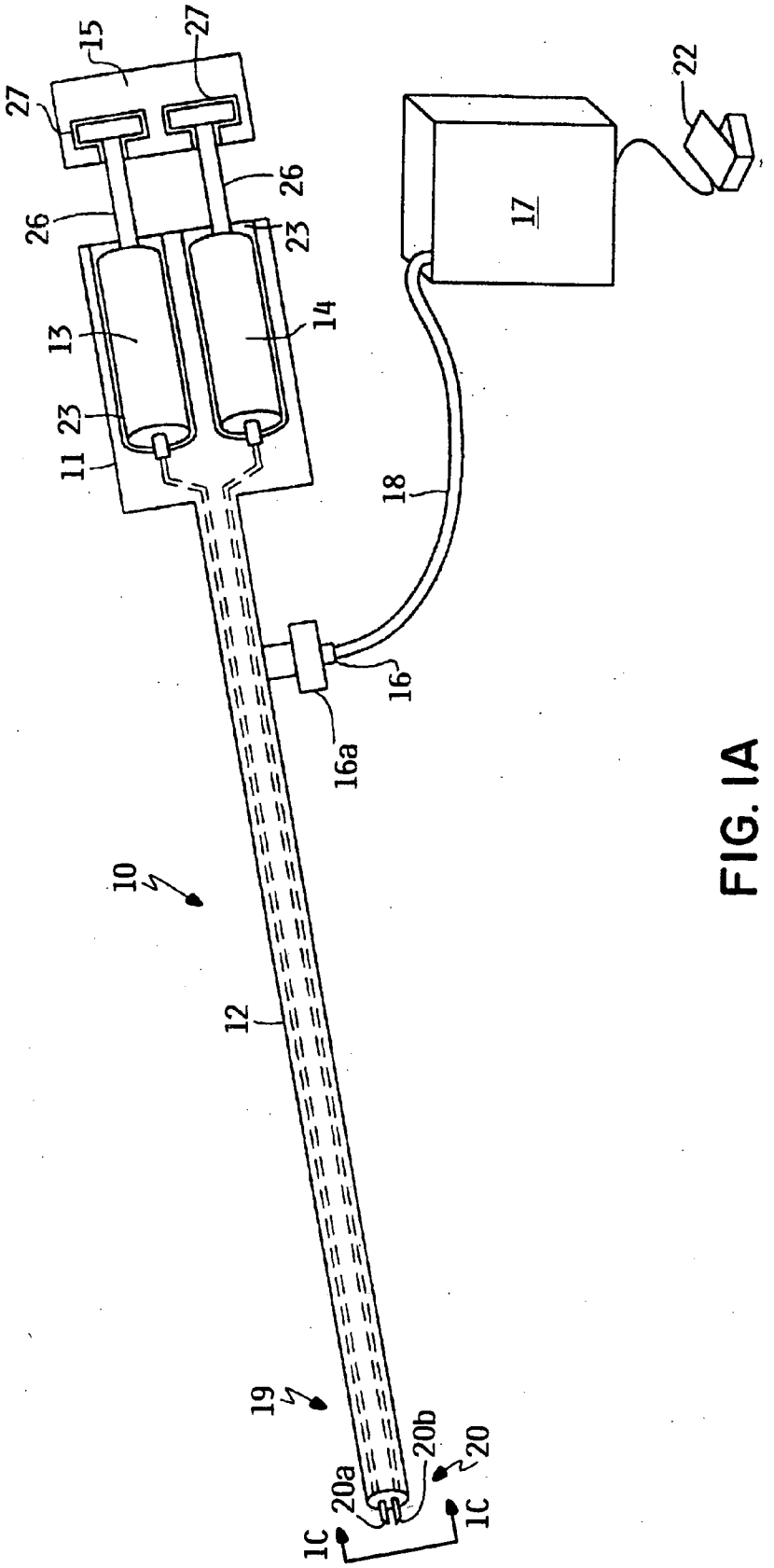


FIG. IA

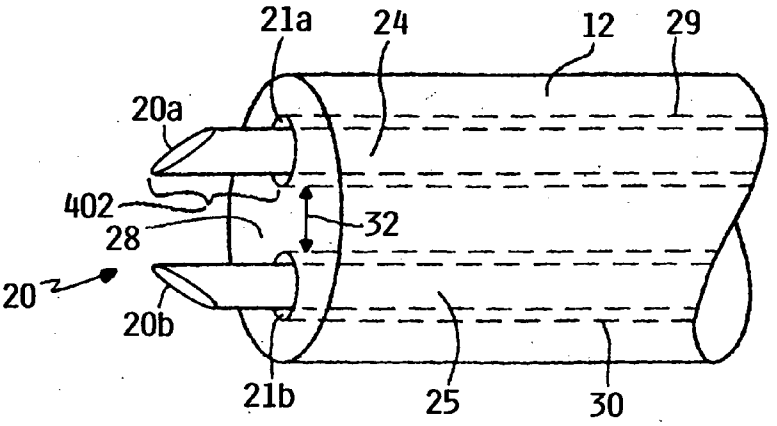


FIG. IB

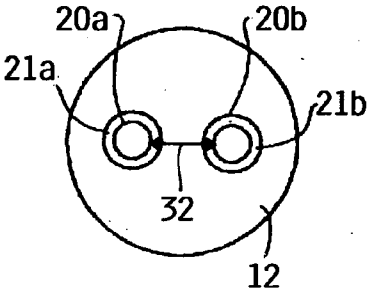


FIG. IC

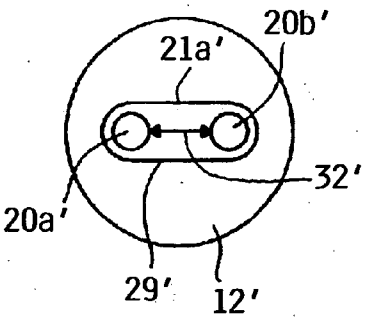


FIG. ID

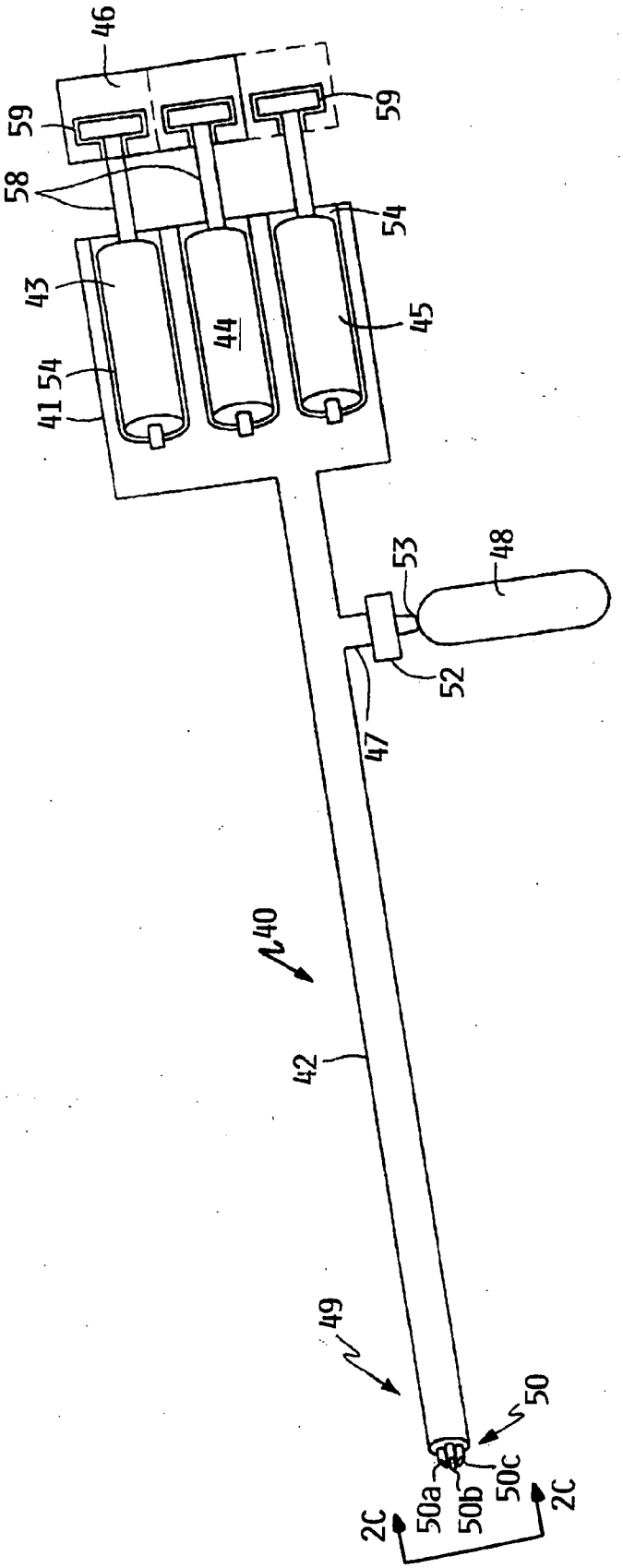


FIG. 2A

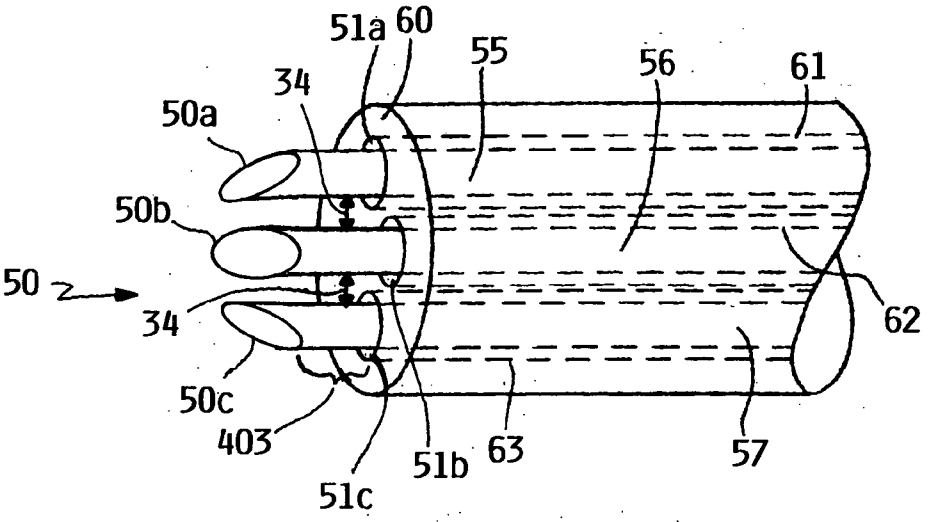


FIG. 2B

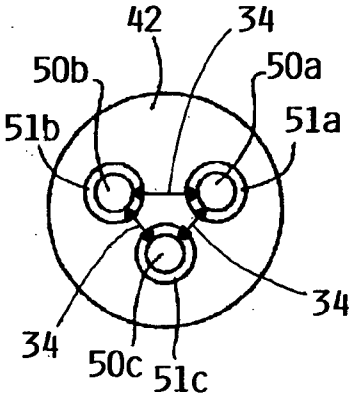


FIG. 2C

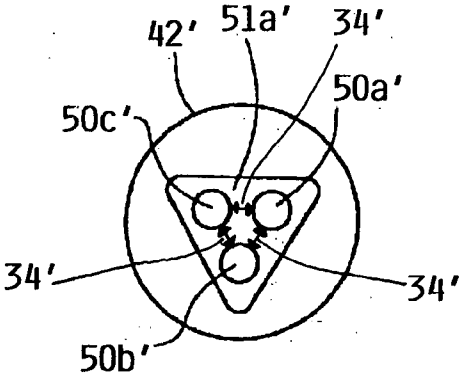


FIG. 2D

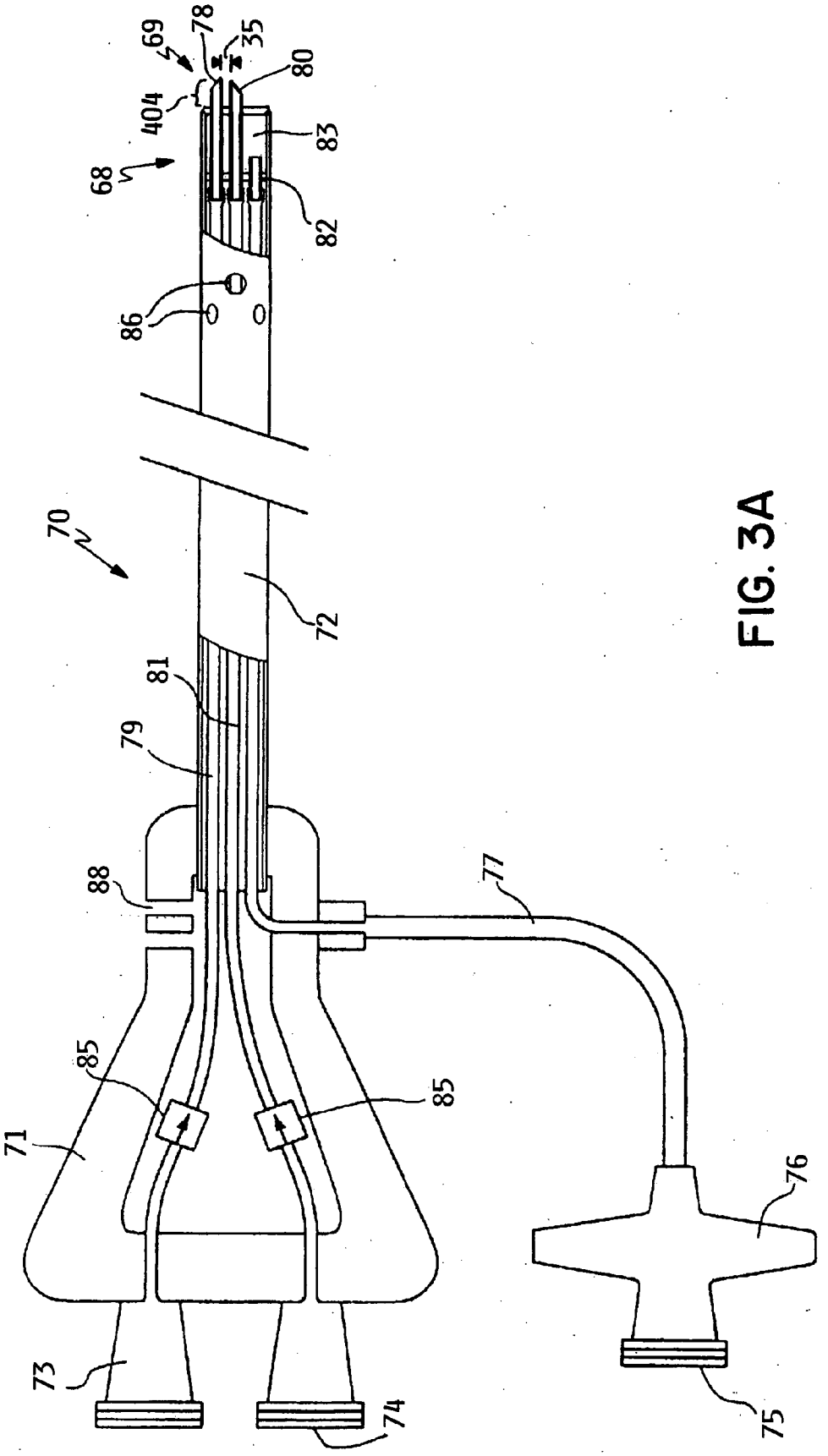


FIG. 3A

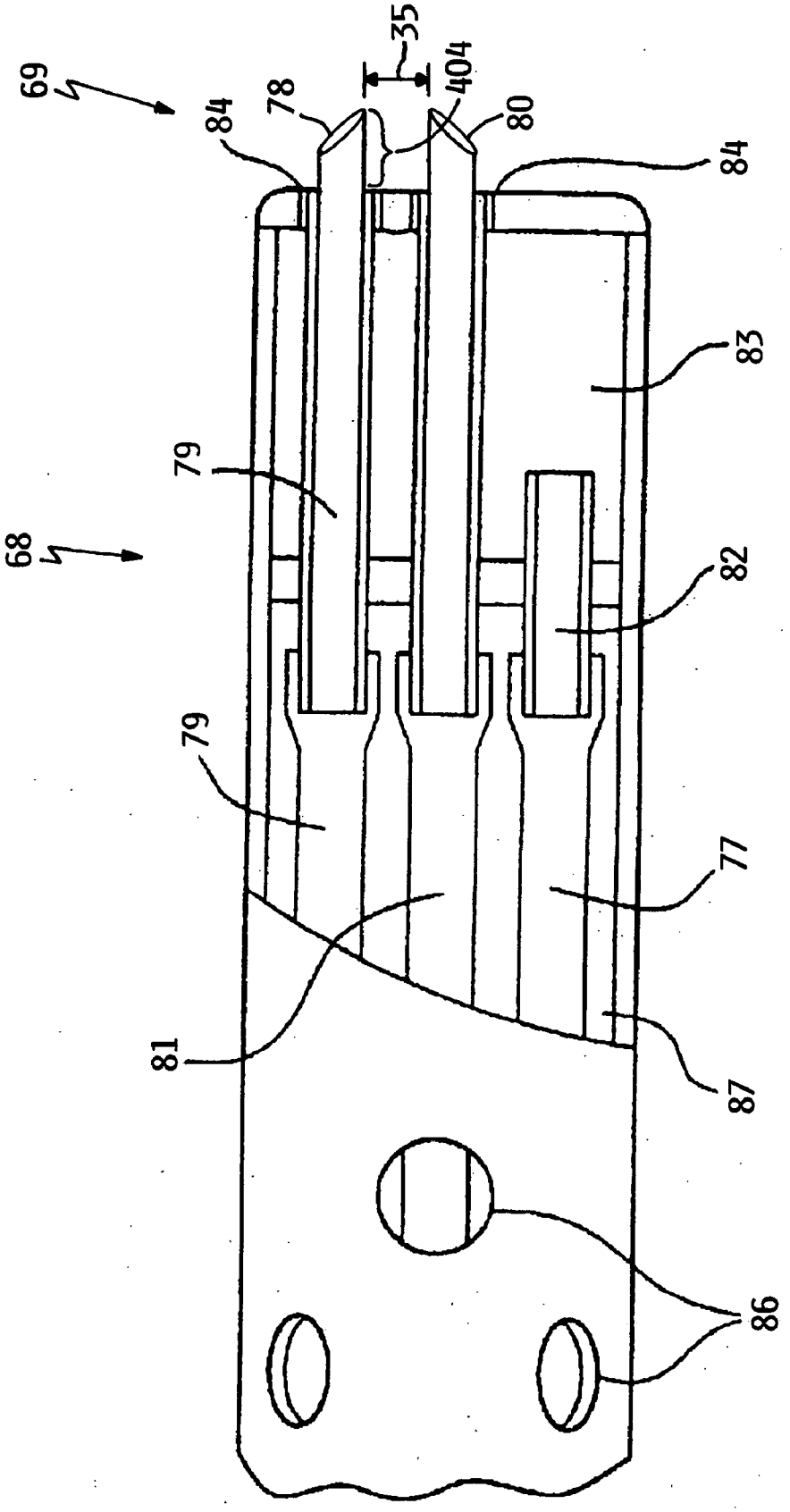


FIG. 3B

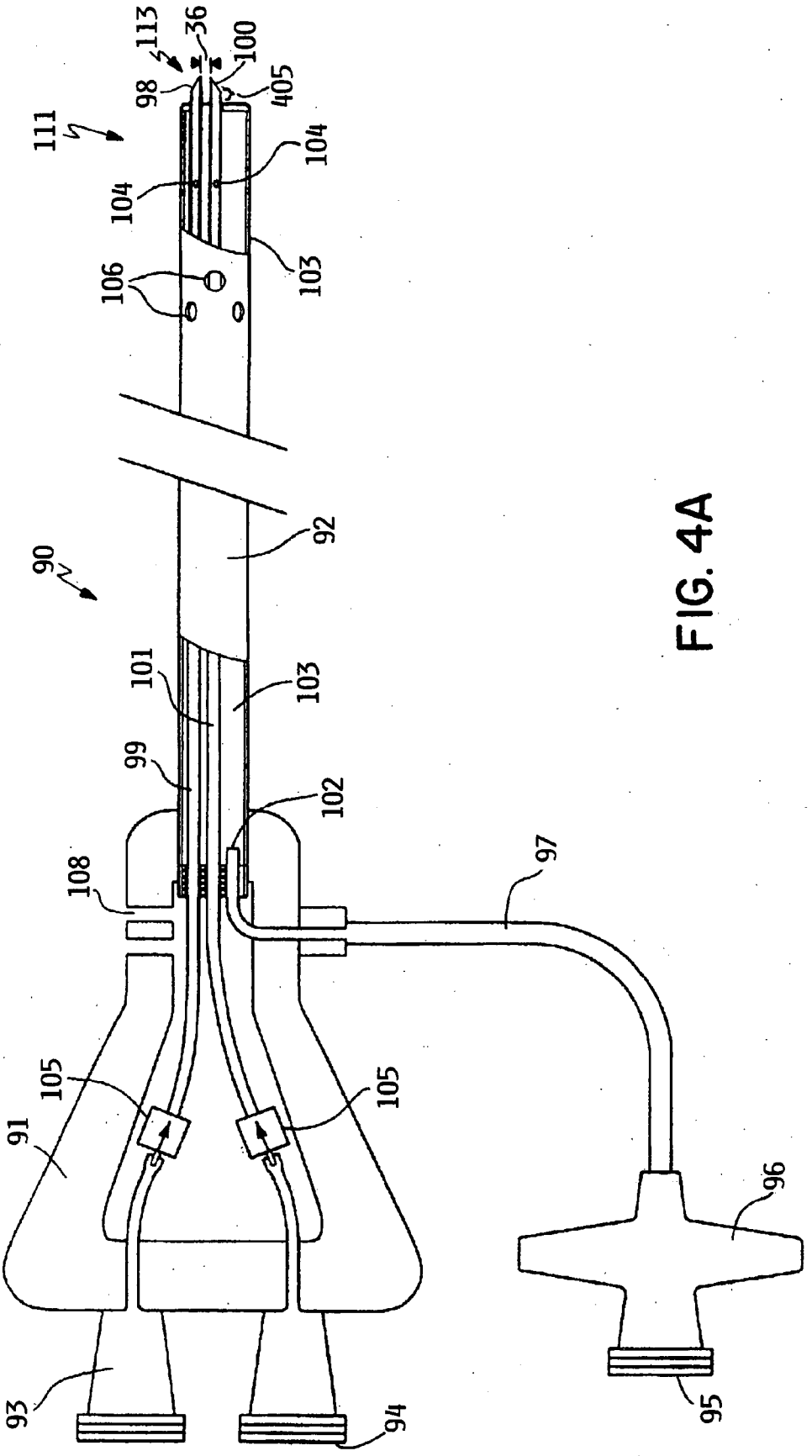

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FIG. 4A

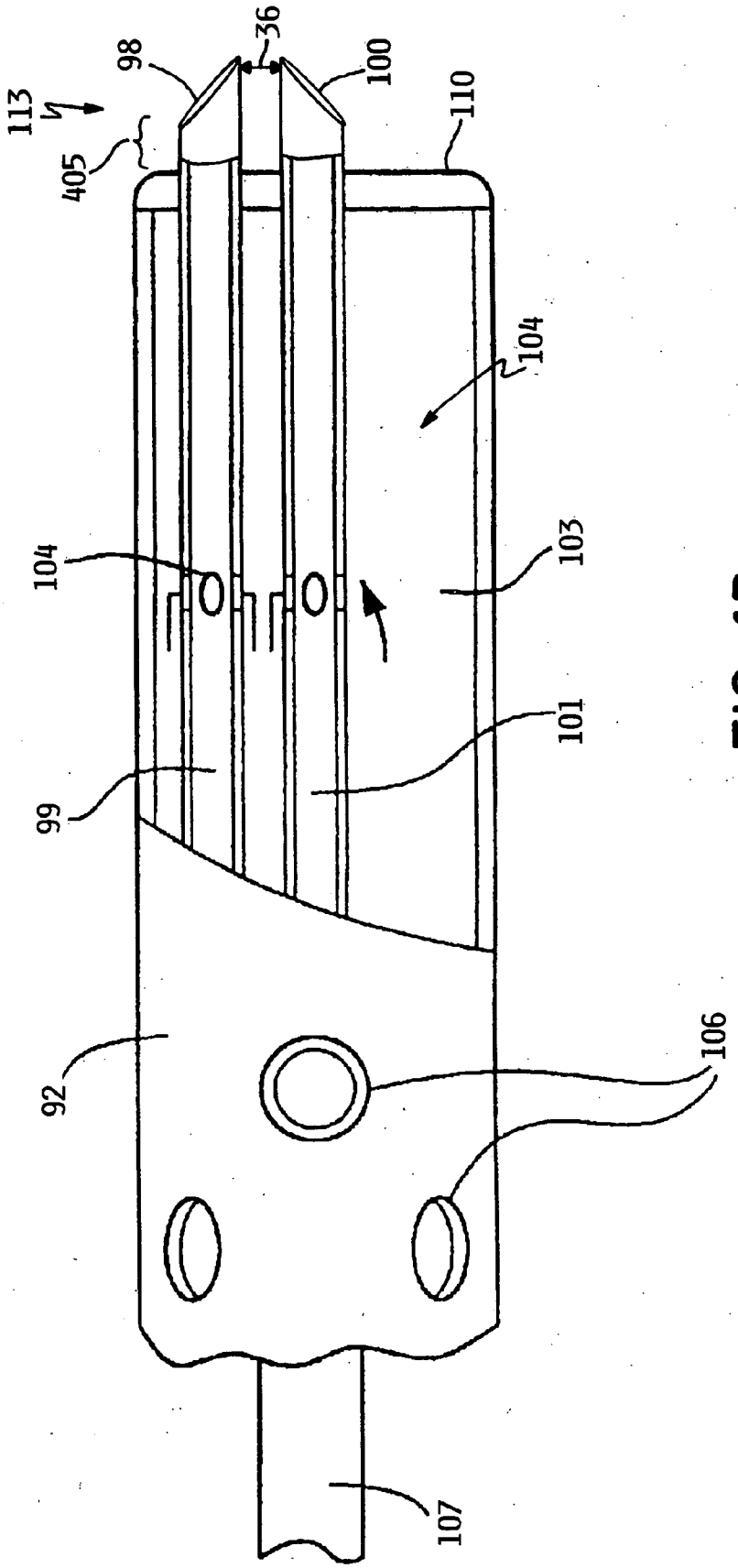

FIG. 4B

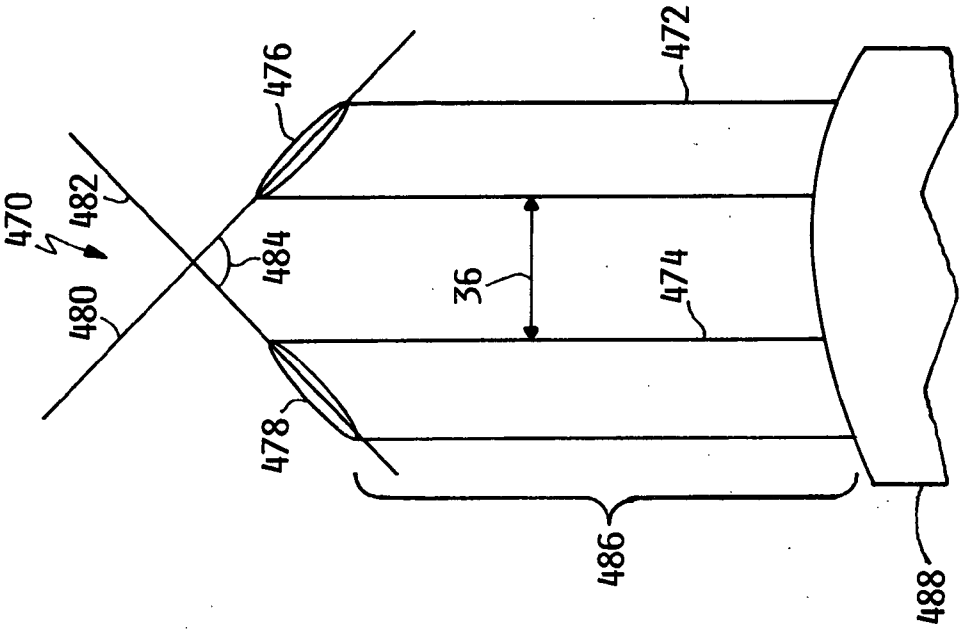
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FIG. 5B

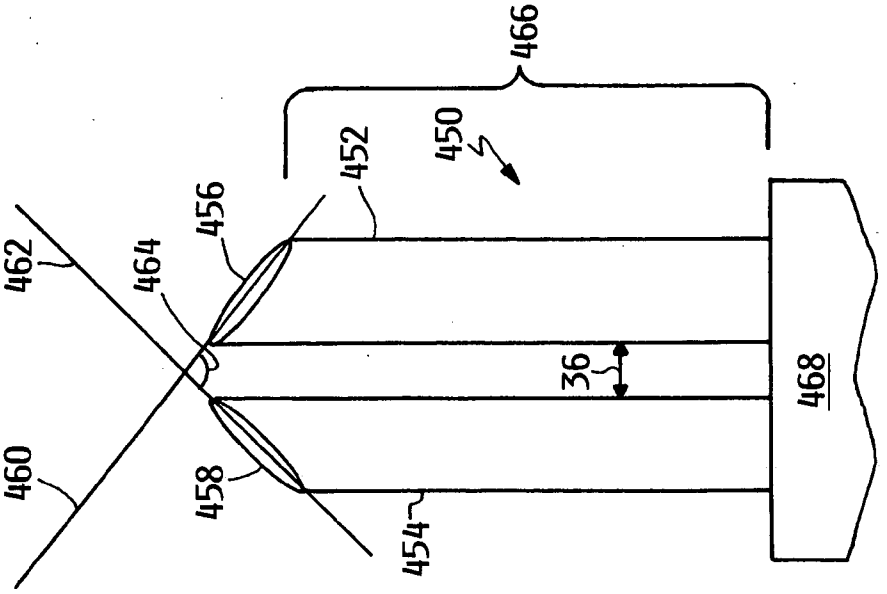
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FIG. 5A

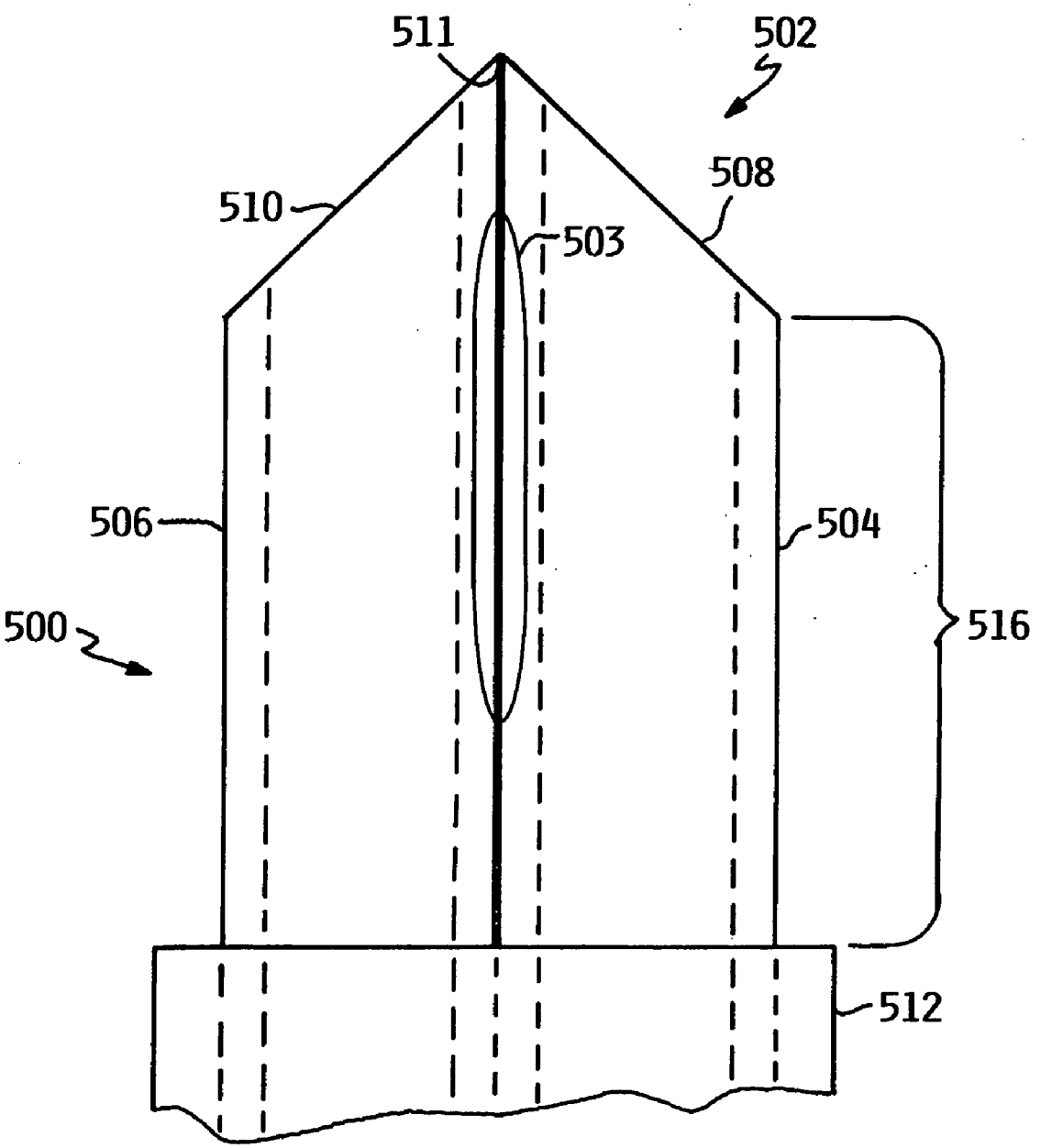

FIG. 6A

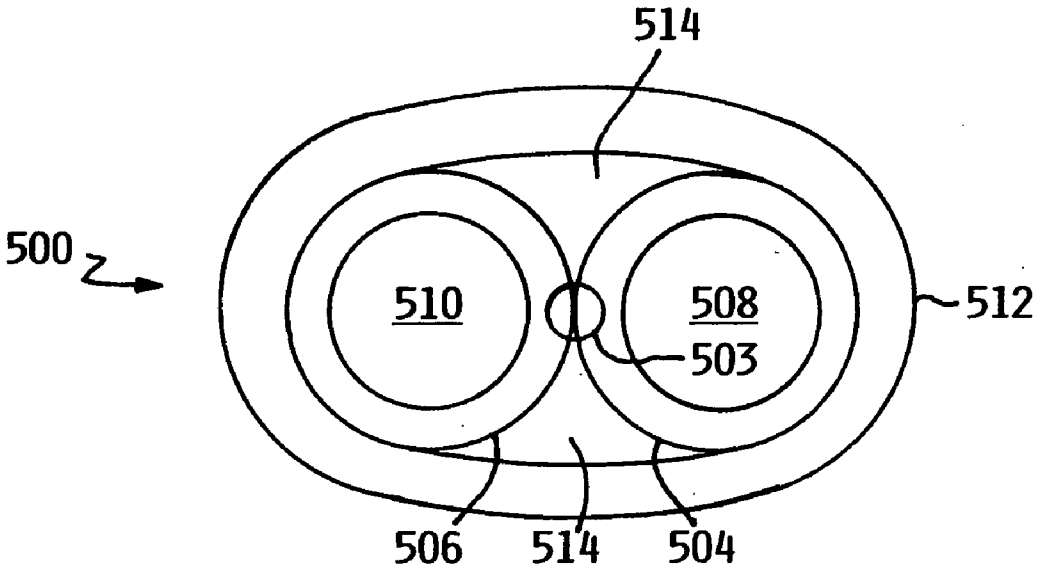
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FIG. 6B

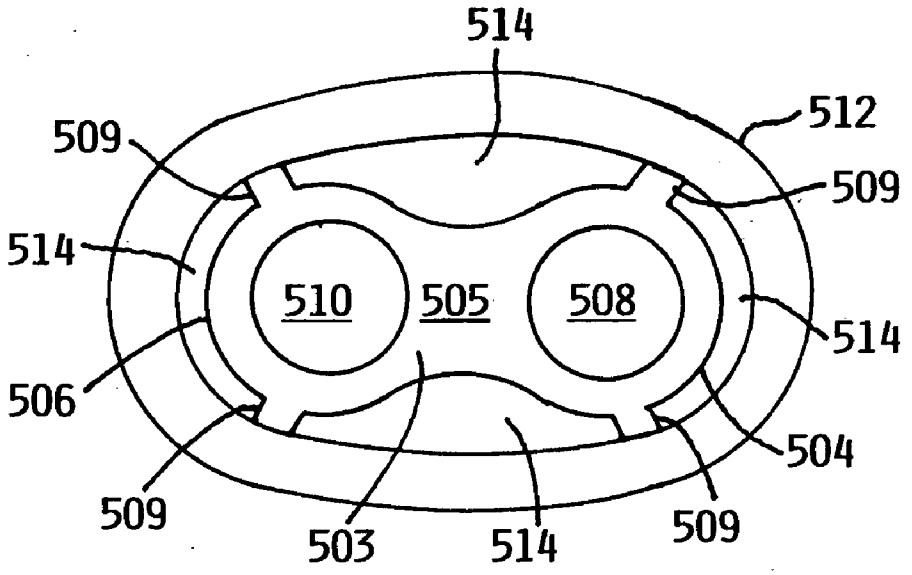
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FIG. 6C

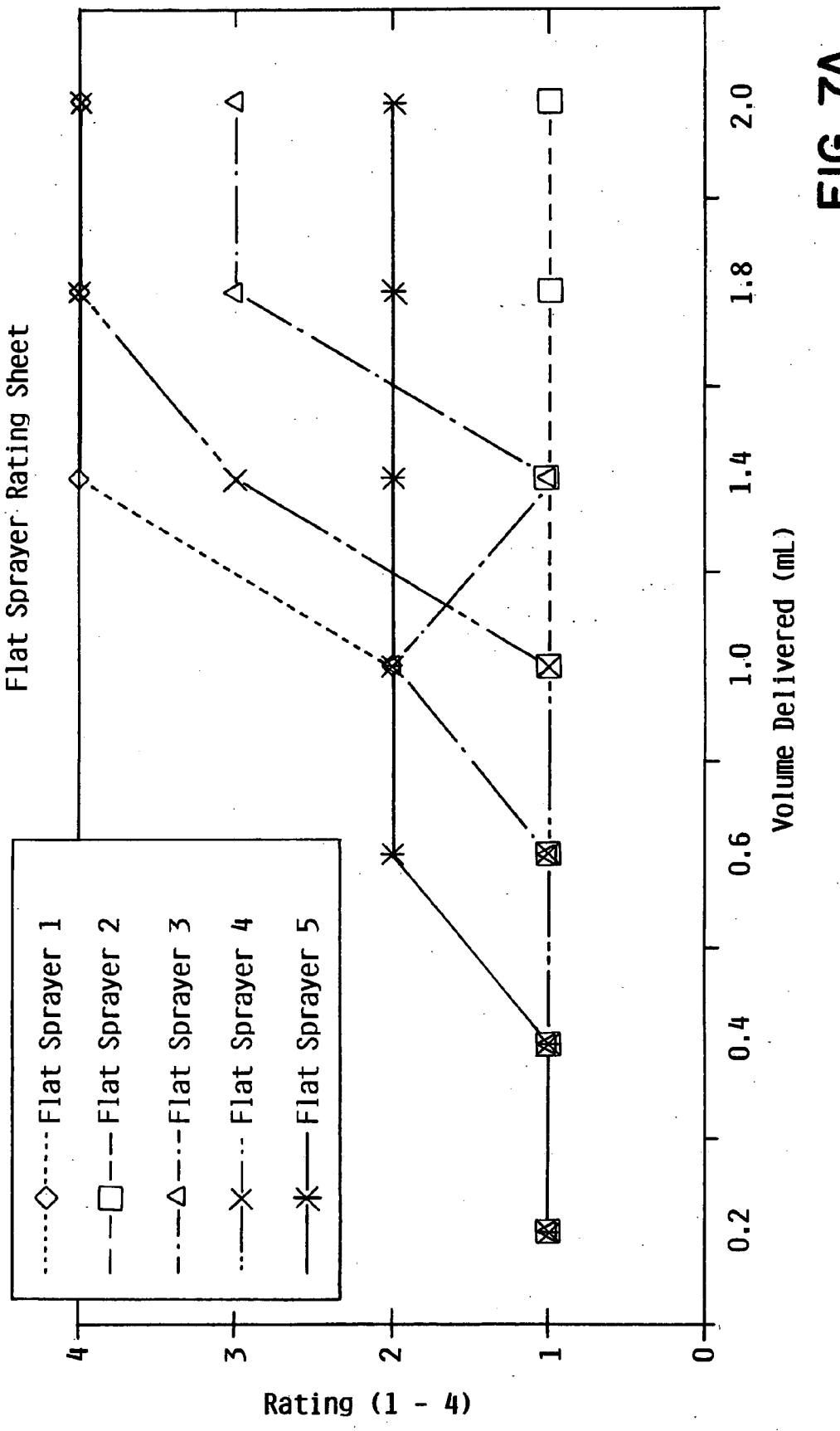
Flat Sprayer Rating Sheet
Flat Sprayer 1
Flat Sprayer 2
Flat Sprayer 3
Flat Sprayer 4
Flat Sprayer 5
Rating (1 - 4)
0
1
2
3
4
0.2
0.4
0.6
1.0
1.4
1.8
2.0
Volume Delivered (mL)

FIG. 7A

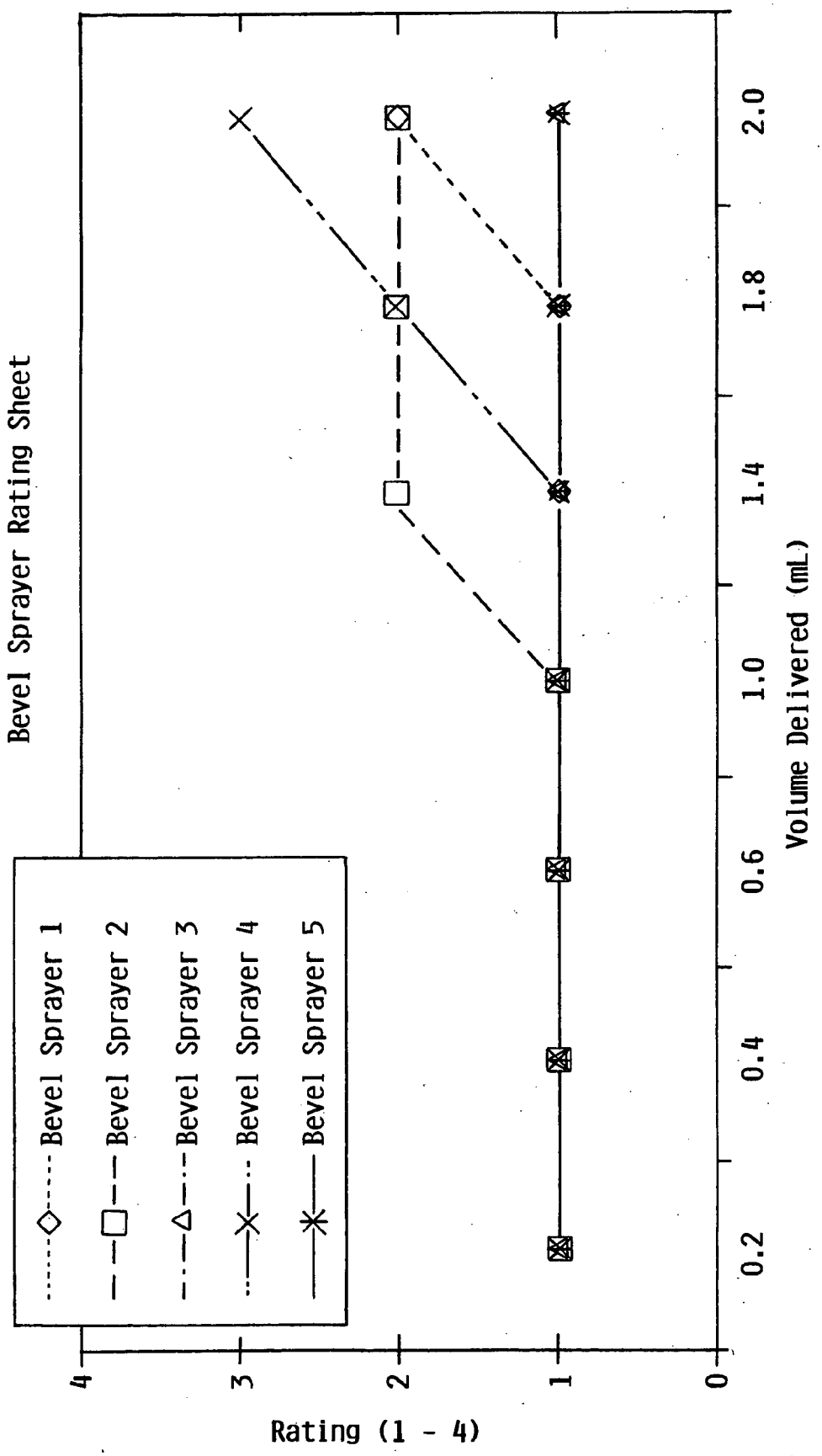
Bevel Sprayer Rating Sheet
Bevel Sprayer 1
Bevel Sprayer 2
Bevel Sprayer 3
Bevel Sprayer 4
Bevel Sprayer 5
Rating (1 - 4)
0
1
2
3
4
0.2
0.4
0.6
1.0
1.4
1.8
2.0
Volume Delivered (mL)

FIG. 7B

SPRAY FOR FLUENT MATERIALS

FIELD OF THE INVENTION

[0001] Certain aspects of the field of the invention relate generally to methods and apparatus for forming biocompatible materials, and, more particularly, to apparatus and methods using an angled tip sprayer for delivering two liquid components that form hydrogels upon mixing.

BACKGROUND OF THE INVENTION

[0002] Often during surgery, tissue may be traumatized or compromised such that it needs to be temporarily supported or isolated during the wound healing period. Materials that may be used as tissue sealants also may be used to temporarily support tissue and to seal leaks from tissue until the tissue heals. Tissue sealants that perform these functions are well known in literature and include a variety of natural and synthetic sealants including fibrin sealants, cyanoacrylate based sealants, and other synthetic sealants and polymerizable macromers.

[0003] Various types of devices have been developed that address many aspects of spraying technologies to deliver sealants. For example, U.S. Pat. No. 5,605,541 to Holm describes apparatus and methods for applying two or more components of a fibrin sealant. U.S. Pat. No. 5,368,563 to Lonneman et al. describes a sprayer assembly having angular connecting channels through which components of a fibrin sealant are discharged to cause mixing. U.S. Pat. No. 5,341,993 to Haber et al. describes a hand held sprayer having a remotely actuated spray tip. U.S. Pat. No. 4,001,391 to Feinstone et al. describes a method for spraying viscous and buttery fluids using a propellant and a pressurized container. U.S. Pat. No. 6,206,905 to Holm et al. describes a method and device for mixing the two components of a biomaterial using various tip configurations of the delivery system for mixing of the components.

SUMMARY OF THE INVENTION

[0004] Applicants have determined that when attempting to use a propellant to apply materials in a laparoscopic setting, which typically is insufflated with a gas to provide a wider field of view for the clinician, the propellant can result in excessive distension of the tissue surrounding the operative site. In addition, in the above laparoscopic context, when a sprayer is first introduced into the surgical site, for example, via a trocar tube, the ambient pressure may inadvertently charge the supply reservoirs (if the supply lines of the sprayer are not already pressurized), thereby interfering with proper dispensing of the materials into the supply lines when the clinician attempts to operate the device.

[0005] These and additional problems have been addressed by U.S. Pat. Nos. 6,152,943, 6,165,201, 6,179,862, 6,379,373, 6,673,093, and 6,689,148, which describe, inter alia, a sprayer capable of applying two or more crosslinkable precursor components to a tissue. The sprayers may have nozzles for each of the crosslinkable precursor components, and may use an annular gas flow outlet or be in communication with a gas-pressurized chamber to form a sealant when the components are mixed. Such sprayers have used nozzles with openings that are substantially parallel to each other, e.g., the openings are side-by-side in the same plane. However, it is possible to improve these devices by further reducing the potential to clog while delivering a fine, controlled amount of sealant in a stop and start motion. Any amount of clogging may be a problem because it can cause occlusion and/or divergent streams, which in turn may cause poor mixing and ultimately a poor sealant.

[0006] One way that clogging may occur is by precursor migration from spray nozzle to spray nozzle ("cross-talk" or cross-contamination). When a component is sprayed out of a nozzle or other opening, it forms a conical pattern that appears as a fan pattern when viewed two-dimensionally. And, when two or more components are sprayed from separate adjacent nozzles or openings, the fan patterns overlap to form a mixing region. However, a low-pressure area adjacent to the openings can exist in the space between the two or more overlapping fan patterns. Precursors may be pulled into the low-pressure area, where they react and clog the openings. A precursor refers to material that is reacted to be incorporated into the material. For example, a monomer is a precursor that may be reacted to be incorporated into a polymeric material. In contrast, a polymerization initiator may react to catalyze formation of a material without becoming incorporated into that material.

[0007] Another mode of clogging may be caused by surface tension. As a result, when a precursor passes through an opening, some of the precursor may tend to remain at or near the opening, and to spread around the opening. Consequently, mutually reactive precursors flowing through openings that are adjacent to each other may tend to become mixed and react at or near the openings.

[0008] Certain embodiments herein describe a solution for these problems by use of an angled applicator tip having openings that are set at an angle relative to each other. An angled tip is in contrast to a tip having the openings substantially parallel to each other. The angled tip may be created, for example, by making a first exit opening and a second exit opening approximately adjacent to each other while defining an angle between the openings that is less than about 140 degrees, e.g., see **FIGS. 5 and 6**. The term tip is conveniently used to denote an end portion or a projecting portion of an apparatus.

[0009] An angle between two openings may be measured by fitting a plane to each opening and measuring the angle formed by the intersection of the two planes. Thus, two openings may define the angle between them when the openings are positioned relative to each other so that there is an angle formed by the intersection of the two planes. Thus two openings that were perpendicular to each other would have an angle of 90 degrees between them. The angle between two flat surfaces is readily measured when every point of an opening falls in a single plane; for example, an opening on a flat surface is disposed in one plane. When an opening is made in a curved surface, however, it is necessary to fit a plane to the opening. The fit may be accomplished using mathematical techniques known to persons of skill in these arts. Without being bound to a particular theory of action, it is believed that the angled tip creates a low-pressure zone between spraying fan patterns of two or more components, thereby drawing the components together in the air stream beyond the tip and improving their mixing. The angled tip also creates a wall or divider between adjacent lumen openings, thereby preventing cross-talk between precursors before they enter the air stream. Further, an angled tip may be more precise and deliver a higher quality gel over the course of an application.

[0010] An advantage of placing the openings adjacent to each other is that such placement facilitates the mingling of compositions that flow through the openings. Openings that are adjacent to each other are typically separated only by a thickness of the material that defines the openings. For example, two needles may be placed adjacent to each other, with their exteriors touching. The openings may be further separated and still be considered to be adjacent. For example, two openings that are separated by a distance of less than about three times the maximum diameter of one of the openings would be adjacent to each other, e.g., see **FIG. 1**.

[0011] Moreover, providing a gap between the openings of an angled tip and any surrounding materials minimizes the role of surface tension. Also, defining an appropriate gas flow rate achieves both good mixing and a good gel while at the same time minimizing clogging, providing that the gas flow is balanced with the need to avoid generating a rush of air that will blow the mixed components from the target location. Minimizing cross-talk and surface tension allows a fine, controlled amount of precursors to be delivered at an appropriate air flow rate in a stop and start motion without clogging.

[0012] Some embodiments relate to apparatus and methods that enable a tissue coating comprising two or more crosslinkable fluids to be applied in situ as a spray. Some embodiments have a reduced risk of clogging of the sprayer due to cross-talk and surface tension. Some of the apparatus and methods permit spraying of polymerizable fluids having precursors in a laparoscopic environment, but adjust the pressure in the cavity to account for the introduction of propellant from the sprayer, thereby avoiding excessive distension of the tissue surrounding the operative site.

[0013] Some embodiments relate to apparatus and methods that permit spraying of polymerizable fluids in a laparoscopic environment, but prevent material reservoirs of the sprayer from being inadvertently pressurized by the backflow of insufflation gases through the supply lines. Certain embodiments provide apparatus and methods that enable a tissue coating comprising two or more crosslinkable fluids to be applied in situ as a spray.

[0014] Certain embodiments may be accomplished by providing a sprayer with an angled tip capable of applying two or more precursors to a tissue to form a coating on the tissue surface. For example, two crosslinkable solutions, each containing one component of a co-initiating system capable of crosslinking when mixed together, may be placed in separate chambers of the sprayer. When the sprayer is activated, the emergent spray contacts tissue, resulting in mixing and crosslinking of the two solutions to form a coating (for example a hydrogel) on the tissue surface.

[0015] In certain embodiments, the sprayer comprises separate spray openings at the spraying end of separate conduits for each of two or more crosslinkable solutions, with each conduit at least partially surrounded by a separate or common gas flow outlet. The crosslinkable solutions are stored in separate compartments, e.g., a multi-cylinder syringe, and communicated under pressure to the spray openings. In the presence of gas flow through the gas flow outlets, the crosslinkable solutions are atomized and mixed in the gas flow to form a spray, which may be used to coat tissue. In an alternative embodiment, the gas flow is mixed with the crosslinkable solutions to both propel the solutions out of the spray openings and atomize the solutions.

[0016] In another embodiment, the sprayer includes a vent system that vents excess pressure from the tissue cavity to avoid excessive distention of the tissue cavity surrounding the operative site in laparoscopic applications.

[0017] In another embodiment, the supply lines include one-way valves that permit flow through the supply line in the distal direction, but prevent backflow into the compartments storing the crosslinkable solutions when the sprayer is first introduced into an insufflated tissue cavity.

[0018] In certain embodiments, the crosslinkable solutions used with the apparatus may be crosslinked using physical crosslinking, chemical crosslinking, or both. For a chemical initiation process, the two or more crosslinkable solutions may polymerize when mixed in the gas flows during spraying, thus forming an adherent coating that adheres to the tissue surface on contact. If a thermal initiating process is used, the two or more solutions may crosslink after contacting the tissue surface and warming to physiological temperatures.

[0019] Alternatively, the two or more solutions may include macromers that contain groups that demonstrate activity towards other functional groups such as amines, imines, thiols, carboxyls, isocyanates, urethanes, amides, thiocyanates, hydroxyls, etc., some of which may be naturally present in, on, or around tissue or may be optionally provided in the region as part of the instilled formulation required to effect the barrier.

[0020] Certain embodiments are directed to a medical device for applying a biocompatible material or a coating in situ comprising at least a first conduit connected to at least a first exit opening and a second conduit connected to at least a second exit opening to deliver a first composition through the first conduit and a second composition through the second conduit to mix the first composition and the second composition outside both the first conduit and the second conduit. The first composition may comprise a precursor to a material formed after the mixing of the first composition and the second composition. The first exit opening and the second exit opening may be approximately adjacent to each other and define an angle that is less than about 60, 90, 120, 140, or 150 degrees. Other embodiments include methods of using the apparatus. Methods of forming tissue adherent barriers in accordance with the principles of the present invention also are provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Certain features of the invention, its nature, and various advantages will be apparent from the accompanying drawings and the following detailed description of certain embodiments, in which:

[0022] **FIGS. 1A, 1B** and 1C, are, respectively, a perspective view of certain embodiments of a two-fluid sprayer, a detailed view of the distal portion of the sprayer, and an end view of the distal portion of the sprayer taken along line 1C-1C of **FIG. 1A**;

[0023] **FIG. 1D** is an end view of the distal portion of an alternative embodiment of the sprayer of **FIG. 1A** taken along line 1C-1C;

[0024] **FIGS. 2A, 2B** and **2**C, are, respectively, a perspective view of an alternative embodiment of the two-fluid sprayer, a detailed view of the distal portion of the sprayer, and an end view of the distal portion of the sprayer taken along line **2**C-**2**C of **FIG. 2A**;

[0025] **FIG. 2D** is an end view of the distal portion of an alternative embodiment of the sprayer of **FIG. 2A** taken along line **2**C-**2**C;

[0026] **FIGS. 3A and 3B**, are respectively, a partially cut-away side and a sectional end view of an alternative embodiment suitable for use in laparoscopic applications;

[0027] **FIGS. 4A and 4B**, are respectively, a partially cut-away side and a sectional end view of a further alternative embodiment suitable for use in laparoscopic applications;

[0028] **FIGS. 5A and 5B**, respectively, are elevated views of alternative embodiments of an angled tip having adjacent conduits that each terminate in an exit opening for dispensing a composition;

[0029] **FIGS. 6A and 6B**, respectively, are an elevated view of an angled tip for an applicator and a top view of the same angled tip having adjacent conduits that each terminate in an exit opening for dispensing a composition;

[0030] **FIG. 6C** is a top view of an alternative embodiment of an angled tip;

[0031] **FIG. 7A** is a graphical view rating the function of flat sprayers; and

[0032] **FIG. 7B** is a graphical view rating the function of angled shape sprayers.

DETAILED DESCRIPTION

[0033] As already discussed, an angled applicator tip having openings that are set at an angle relative to each other may advantageously be used to dispense biocompatible materials. Further, a gas flow outlet may be positioned relative to the openings so that compositions flowing from the openings are readily removed from the area of the openings by the action of the gas. And certain flow rates may advantageously be used to reduce clogging of the openings while maintaining a consistent deposition of compositions onto a surface.

Applicators for Dispensing Compositions for Forming Biocompatible Materials In Situ in a Patient

[0034] In many embodiments, a medical device applicator has a body with a distal portion. The distal portion has a distal tip with two or more openings. Each opening has a conduit for fluid connection to a source of a composition that is to be dispensed through the opening. The source may be, e.g., a chamber that is permanently or reversibly connectable to the device to be in fluid communication with the conduit. A gas source provides gas to dispense the compositions from the openings.

[0035] The gas may be used in a variety of ways to dispense the compositions. For example, the gas may be placed behind the compositions to push them through the openings. Or the gas may be forced into a chamber with the composition to mix with the composition and elevate the chamber pressure so that the gas-composition mixture is forced from the chamber when the chamber is opened. Or the gas may be directed through a gas flow outlet that surrounds, or is near, the openings for the compositions, so that the flow of the gas pulls the compositions from their openings. This latter method advantageously reduces the size of the vessel used to provide the compositions to the apparatus.

[0036] The medical device applicator sprayer may be directed to the use of multi-component crosslinkable solutions to form materials in situ in a patient, e.g., to prevent post-surgical adhesions, or as drug delivery layers. In accordance with the methods of certain embodiments, two or more crosslinkable solutions are sprayed onto tissue during, or near the completion, of surgery to form adherent coatings. Multi-component hydrogel systems suitable for such use, apparatus for dispensing such hydrogel systems, and examples of use of the inventive methods and apparatus are described.

[0037] Referring now to **FIGS. 1A, 1B**, and **1**C, an illustrative embodiment of a sprayer medical device is described. Sprayer **10** comprises body **11** having elongated barrel **12**, syringes **13** and **14**, actuator **15** and gas inlet port **16** coupled to compressor **17** via flexible hose **18**. Distal portion **19** of sprayer **10** includes a distal tip **20**, which has distal tip openings **20***a* and **20***b*. Compressor **17** supplies a gas flow, preferably compressed air or carbon dioxide, to sprayer **10** either continuously, or when activated by foot-pedal **22**. Gas inlet port **16** may include filter **16***a* to remove particulate contaminants, including bacteria and other microorganisms, from the gas flow.

[0038] The gas flow outlet may be placed adjacent to, and proximal to, the openings for the compositions, as in **FIG. 1**, which depicts gas flow outlets **21***a*, **21***b*, and **21***a*', and openings **20***a*, **20***b*, **20***a*', and **20***b*' disposed in the endface of barrel **12**. In this configuration, there is a gap **402** wherein gas flowing from the gas flow outlet flows past the tube that opens into an outlet, **20***a*, **20***a*', **20***b*. The flowing gas tends to keep the openings clear of compositions that flow out of openings **20***a*, **20***b*, **20***a*', and **20***b*'. A spacing distance between the openings provides a separation that reduces opportunities for unwanted cross-talk between the openings, as shown by element **32** in **FIGS. 1A, 1B**, and **1**C, and by element **32**' in **FIG. 1D**.

[0039] Body **11** includes chambers **23** into which syringes **13** and **14** are placed so that the outlets of the syringes are coupled in fluid communication with distal tip openings by way of interior conduits **24** and **25**. Each of syringes **13** and **14** includes plunger **26** that may be engaged in recesses **27** of actuator **15**. Accordingly, when actuator **15** is depressed, an equal volume of crosslinkable solution is dispensed from each of syringes **13** and **14**. Alternatively, for some systems it may be desirable to omit actuator **15** and instead spray the crosslinkable solutions onto the tissue in a sequential fashion. In either case, sterile crosslinkable solutions may be stored separately in syringes **13** and **14**, and assembled in sprayer **10** as required for a particular application.

[0040] Conduit **24** extends from the proximal end of barrel **12**, where it is coupled to syringe **13**, to a point a slightly beyond distal endface **28** of barrel **12**, where it forms opening **20***a*. Conduit **24** is disposed within lumen **29** that communicates with gas inlet port **16**. Gas entering sprayer **10** via gas inlet port **16** flows through the annular space

defined by the exterior of conduit **24** and the interior surface of lumen **29**, exiting sprayer **10** through gas flow outlet **21***a*. As the gas, preferably air or carbon dioxide, flows through gas flow outlet **21***a*, it mixes with the crosslinkable solution from syringe **13** passing through opening **20***a*, breaking the crosslinkable solution into fine droplets or a mist.

[**0041**] Likewise, conduit **25** extends from the proximal end of barrel **12**, where it is coupled to syringe **14**, to a point a slightly beyond distal endface **28** of barrel **12**, where it forms opening **20***b*. Conduit **25** is disposed within lumen **30** that communicates with gas inlet port **16**. Thus, gas entering sprayer **10** via gas inlet port **16** flows through the annular space defined by the exterior of conduit **25** and the interior surface of lumen **30**, exiting sprayer **10** through gas flow outlet **21***b*. As the gas flows through gas flow outlet **21***b*, it mixes with the crosslinkable solution from syringe **14** passing through opening **20***b*, also breaking the crosslinkable solution into fine droplets or a mist.

[**0042**] Openings **20***a* and **20***b* are preferably arranged so that the crosslinkable droplets or mist formed by opening **20***a* and gas flow outlet **21***a* converges with that formed by opening **20***b* and gas flow outlet **21***b* to provide a spray containing a mixture of the two crosslinkable solutions. As described hereinabove, the two solutions may either crosslink on contact within the spray, or crosslink upon contacting the tissue. Openings **20***a* and **20***b* are also preferably arranged so as to minimize clogging of the distal tip **20** by premature crosslinking of the emergent fluids by cross-contamination. An aspect of minimizing the cross-contamination is the optional use of a separation distance between the openings, e.g., as shown in **FIGS. 1A-1D** and denoted by elements **32** and **32'**.

[**0043**] The distal tip **20** has an angled shape that helps to reduce cross-contamination of the emergent compositions. The angled shape of the distal tip **20** is the arrangement of the openings **20***a* and **20***b* with respect to each other.

[**0044**] Referring to **FIGS. 1A-1C**, as a further alternative, instead of using footpedal **22** to regulate the gas flow, compressor **17** may be regulated with a valve (not shown) disposed on body **11** or barrel **12**, that selectively diverts gas flow from lumens **29** and **30**. This feature may be particularly useful when the sprayer is used in closed relatively fluid tight cavities, such as the pneumoperitoneum created during laparoscopic or pelvic surgery.

[**0045**] Body **11**, barrel **12** and actuator **15** preferably are constructed from a plastic such as polyethylene, while conduits **24** and **25** preferably comprise a rigid material, such as stainless steel. Syringes **13** and **14** may comprise materials typically used in medical devices, while compressor **17** and flexible hose **18** may be of the type commercially available, for example, that are used with airbrushes.

[**0046**] In operation, sprayer **10** is coupled to compressor **17** via flexible hose **18**. Syringes **13** and **14** are inserted into chambers **23** of body **11** and plungers **26** of syringes **13** and **14** are engaged in recesses **27** in actuator **15**. Distal portion **19** of sprayer **10** is disposed within a body cavity, for example, intraoperatively in the abdomen or laparoscopically in the pneumoperitoneum, a few inches from tissue to be coated. Footpedal **22** is then depressed to activate compressor **17**, while actuator **15** is depressed to dispense crosslinkable solutions from openings **20***a* and **20***b*. As the solutions emerge from openings **20***a* and **20***b*, they are atomized and partially or completely mixed, and directed onto the tissue to be coated. As a result of crosslinking, for example, induced by free radical or chemical crosslinking, the solutions form a film that adheres to the tissue to provide a therapeutic benefit. Alternatively, the solutions may be mixed when they contact the tissue surface.

[**0047**] In **FIG. 1D**, an alternative embodiment is depicted in which barrel **12'** includes openings **20***a'* and **20***b'* disposed within single gas flow outlet **21***a'* and gas flow lumen **29'**. The first opening and the second opening are adjacent to a gas flow outlet, and the gas flow outlet surrounds at least the first opening, and, in the case of **FIG. 1D**, two openings. Operation of this alternative embodiment is similar to that described hereinabove, except that the crosslinkable solutions are entrained from openings **20***a'* and **20***b'* by a single stream of gas exiting gas flow outlet **21***a'*. In addition, the sprayer may include a valve or valves (not shown) for regulating the amount of crosslinkable solution and gas exiting openings **20***a'*and **20***b'* and gas flow outlet **21***a'*, respectively. Such valves also may permit a jet of gas to be directed onto a targeted tissue, for example, to displace saline or body fluids to dry or clean the target tissue prior to instillation of the hydrogel barrier. Separation distance **32'** provides a separation between the openings to reduce unwanted cross-contamination between the openings.

[**0048**] Referring now to **FIGS. 2A, 2B** and 2C, an alternative embodiment of a sprayer for forming materials such as adherent tissue coatings from a three-part hydrogel system is described. Sprayer **40** comprises body **41** having elongated barrel **42**, syringes **43**, **44**, and **45**, actuator **46** and gas inlet port **47** coupled compressed gas cylinder **48**. Distal portion **49** of sprayer **40** includes distal tip **50** and openings **50***a*, **50***b* and **50***c*. Distal tip **50** also has conduits **55**, **56**, and **57** which are at least partially surrounded by gas flow outlets **51***a*, **51***b* and **51***c*, respectively. Compressed gas cylinder **48** is coupled to gas inlet port **47** via valve **52** and filter **53**. Valve **52** is configured, for example, so that it may be selectively opened or closed by rotating the valve a half-turn. Filter **53** serves the same functions as filter **16***a* in the embodiment of **FIG. 1**.

[**0049**] Body **41** includes chambers **54** into which syringes **43**, **44** and **45** are placed so that the outlets of the syringes are coupled in fluid communication with openings **50***a*, **50***b*, and **50***c* by conduits **55**, **56** and **57**, respectively. Each of syringes **43-45** includes plunger **58** that may be engaged in recesses **59** of actuator **46**. Actuator **46** may link all three of plungers **58** together for common motion, or may be used to link only two of the plungers together, as illustrated by the dotted line in **FIG. 2A**. Actuator **46** may therefore be depressed to dispense equal volumes of crosslinkable solution from each of syringes **43-45** or just a subset thereof. As in the embodiment of **FIG. 1A**, the construction of sprayer **40** permits the sterile crosslinkable solutions to be stored separately in syringes **43-45**, and assembled in sprayer **40** as required for a particular application.

[**0050**] Conduit **55** extends from the proximal end of barrel **42**, where it is coupled to syringe **43**, to a point slightly beyond distal endface **60** of barrel **42**, where it forms opening **50***a*. Conduit **55** is disposed within lumen **61** that communicates with gas inlet port **47**. Gas entering sprayer **40** via gas inlet port **47** flows through the annular space

defined by the exterior of conduit **55** and the interior surface of lumen **61**, exiting sprayer **40** through gas flow outlet **51***a*. As the gas, preferably air or carbon dioxide, flows through gas flow outlet **51***a*, it mixes with the crosslinkable solution from syringe **43** passing through opening **50***a*, and atomizes the crosslinkable solution into fine droplets or a mist. Conduit **56**, disposed in lumen **62**, and conduit **57**, disposed in lumen **63**, are similarly arranged to atomize crosslinkable solutions from syringes **44** and **45** in the gas flows exiting gas flow outlets **51***b* and **51***c*.

[**0051**] The gas flow outlet may be placed adjacent to, and proximal to, the openings for the compositions, as in **FIGS. 2A and 2B**, which depict gas flow outlets **51***a*, **51***b*, and **51***c* relative to having openings **50***a*, **50***b*, and **50***c* disposed in the endface of barrel **42**. In this configuration, there is a gap **403** wherein gas flowing from the gas flow outlet flows past the tube that opens into an outlet, **50***a*, **50***b*, and **50***c*. The flowing gas tends to keep the openings clear of compositions that flow out of openings **50***a*, **50***b*, and **50***c*. Openings **50***a*, **50***b*, and **50***c* are separated from each other by a separation distance denoted by element **34**. The separation distance helps to prevent cross-contamination between the compositions that exit the openings.

[**0052**] With respect to **FIG. 2D**, an alternative embodiment is depicted in which barrel **42'** includes openings **50***a'*, **50***b'* and **50***c'* disposed within single gas flow outlet **51***a'* and gas flow lumen **61'**. Operation of this alternative embodiment is similar to that described hereinabove, except that the crosslinkable solutions are entrained from openings **50***a'*, **50***b'* and **50***c'* by a single stream of gas exiting gas flow outlet **51***a'*. In addition, like the embodiment described with respect to **FIG. 1D**, the sprayer may include a valve or valves for regulating the amount of crosslinkable solution and gas exiting the openings of the distal end, and also may permit a jet of gas to be directed onto a targeted tissue to displace saline or body fluids, thereby drying or cleaning the target tissue prior to instillation of the hydrogel barrier. The openings are separated from each other by a separation distance denoted by element **34** or **34'**. The separation distance helps to prevent cross-contamination between the compositions that exit the openings.

[**0053**] The embodiments of **FIG. 2** may be advantageously used to dispense a three-component hydrogel system to form a biocompatible material, e.g., an adherent therapeutic layer on a tissue surface. Alternatively, syringes **43** and **44** may contain components of crosslinkable solution that are activated to initiate crosslinking by mixing the two solutions. Syringe **45** may then contain a further crosslinkable solution that enhances adherence of the coating to tissue, for example, by providing a highly crosslinked network as the base coat or by helping the top coat adhere better to the tissue surface by other mechanisms.

[**0054**] Referring now to **FIGS. 3A and 3B**, a further alternative embodiment of the sprayer is described which is adapted for use in laparoscopic applications. Sprayer **70** comprises-body **71** having elongated barrel **72**, a distal portion **68** containing a distal tip **69**, material supply ports **73** and **74**, an actuator (not shown) and gas inlet port **75** coupled to a source of compressed gas or a compressor (not shown) via filter **76** and flexible hose **77**. Supply port **73** is coupled to opening **78** by supply line **79** while supply port **74** is coupled to opening **80** by supply line **81**. Gas inlet port **75** is coupled by hose **77** to gas flow **82** disposed in chamber **83**. Gas exiting gas flow outlet **82** flows into chamber **83**, and then exits chamber **83** by flowing through gas flow outlet **84** surrounding openings **78** and **80**, as for the embodiment of **FIG. 1**.

[**0055**] Reservoirs of crosslinkable solutions are coupled to supply ports **73** and **74**, so that when sprayer **70** is actuated, compressed gas flowing around openings **78** and **80** draws the crosslinkable solutions through supply lines **79** and **81**. The gas flow exiting through annular gaps **84** atomizes and mixes the crosslinkable solution, and deposits the crosslinkable solutions onto a target tissue.

[**0056**] In accordance with one embodiment, one-way valves **85** are disposed on supply lines **79** and **81** to prevent backflow of insufflation gases in a tissue cavity from charging the reservoirs of crosslinkable solutions. More specifically, one-way valves permit flow through the supply lines from the reservoirs to openings **78** and **80**, but prevent the backflow of insufflation gases in a tissue cavity from flowing into the reservoirs when the sprayer is first introduced into the tissue cavity. Additionally, one-way valves prevent compressed gas from the sprayer from being directed through the supply lines if, for example, if the distal end of the sprayer were pushed into tissue or otherwise blocked.

[**0057**] During laparoscopic surgery, for example, in the peritoneal cavity, it is typical to employ an insufflator to create a gas-filled cavity in which the surgeon can view and manipulate his or her instruments. Such devices inject a pressurized gas, such as carbon dioxide, and monitor and regulate the insufflation pressure by adding additional carbon dioxide to compensate for any leakage. Once a patient is insufflated, experienced surgeons typically maintain the insufflation without requiring much additional carbon dioxide.

[**0058**] Because the methods and apparatus of the present invention employ a pressurized gas to atomize and deposit the crosslinkable solution, however, a vent system must be provided to prevent excessive distension of the tissue cavity. Accordingly, sprayer **70** includes one or more vent holes **86** that communicate with bore **87** of elongated barrel **72** and proximal vent holes **88** in body **71**. Vent holes **86** and proximal holes **88** permit excess gas pressure to be vented from the tissue cavity through the sprayer. While carbon dioxide will leak from the peritoneal cavity through vent holes **86** and **88**, when there is no gas flow from the sprayer, applicants do not expect this leakage to present a problem, because the insufflator will add additional carbon dioxide to compensate for this leakage.

[**0059**] In operation, sprayer **70** is coupled to a source of compressed gas or a compressor via filter **76** and hose **77**. Reservoirs of crosslinkable solutions are coupled to supply ports **73** and **74**. The distal end of sprayer **70** then is disposed within a body cavity, for example, intraoperatively in the abdomen or laparoscopically in the pneumoperitoneum, a few inches from tissue to be coated. When sprayer **70** is actuated, for example, by a footpedal (not shown) coupled to the compressor or source of compressed gas, crosslinkable solutions from openings **78** and **80** by gas exiting through gas flow outlets **84**. As the solutions emerge from openings **78** and **80**, they are atomized and mixed, and directed onto the tissue to be coated. As a result of crosslinking, for

example, induced by free radical or chemical crosslinking, the solutions form a film that adheres to the tissue to provide a therapeutic benefit.

[0060] Openings **78** and **80** are preferably arranged so that the atomized crosslinkable solutions converge to provide a spray containing a mixture of the crosslinkable solutions. Openings **78** and **80** may extend beyond distal endface **60** of barrel **72** to form gap **404**, which assists to prevent clogging of the openings. The distal tip of sprayer **70** is angled, with adjacent openings **78**, **80** defining an angle of about 100 degrees. The openings are separated from each other by separation distance **35** to provide a separation that decreases opportunities for cross-contamination between the openings.

[0061] Referring to **FIGS. 4A and 4B**, another alternative laparoscopic embodiment of the sprayer is described. Sprayer **90** comprises body **91** having elongated barrel **92**, a distal portion **111** containing a distal tip **113**, material supply ports **93** and **94**, an actuator (not shown) and gas inlet port **95** coupled to a source of compressed gas or a compressor (not shown) via filter **96** and flexible hose **97**. Supply port **93** is coupled to opening **98** by supply line **99** while supply port **94** is coupled to opening **100** by supply line **101**. Gas inlet port **95** is coupled by hose **97** to outlet **102** disposed in chamber **103**. Gas exiting outlet **102** flows into chamber **103** and then exits chamber **103** by flowing through openings **104** into supply lines **99** and **101**.

[0062] Reservoirs of crosslinkable solutions are coupled to supply ports **93** and **94**, so that when sprayer **90** is actuated, gas introduced into chamber **103** enters supply lines **99** and **101** through openings **104**, mixes with and atomizes the crosslinkable solutions in the supply lines, and propels the solutions to exit through openings **98** and **100**. As the gas flow and solution mixture exits through openings **98** and **100**, it further atomizes and mixes the crosslinkable solutions, and deposits the solutions onto a target tissue. The openings **98** and **100** are arranged so as to have a distal tip **113** as described hereinabove.

[0063] One-way valves **105** may be disposed on supply lines **99** and **101** to prevent backflow of gas from chamber **103** or insufflation gases in a tissue cavity from charging the reservoirs of crosslinkable solutions. More specifically, one-way valves permit flow through the supply lines from the reservoirs to nozzles **98** and **100**, but prevent the backflow of insufflation gases in a tissue cavity from flowing into the reservoirs when the sprayer is first introduced into the tissue cavity. Additionally, one-way valves prevent compressed gas from chamber **103** of the sprayer from being directed through the supply lines if, for example, if the distal end of the sprayer were pushed into tissue or otherwise blocked.

[0064] In addition, sprayer **90** includes one or more vent holes **106** that communicate via tubing **107** disposed within elongated barrel **92** and proximal vent holes **108** in body **91**. Vent holes **106** and proximal holes **108** permit excess gas pressure to be vented from the tissue cavity through the sprayer. While carbon dioxide will leak from the peritoneal cavity through vent holes **106** and **108** when there is no gas flow from the sprayer, applicants do not expect this leakage to present a problem, because the insufflator will add additional carbon dioxide to compensate for this leakage.

[0065] In operation, sprayer **90** is coupled to a source of compressed gas or a compressor via filter **96** and hose **97**. Reservoirs of crosslinkable solutions are coupled to supply ports **93** and **94**. The distal portion **111** of sprayer **90** then is disposed within a body cavity, for example, intraoperatively in the abdomen or laparoscopically in the pneumoperitoneum, a few inches from tissue to be coated. When sprayer **90** is actuated, for example, by a footpedal (not shown) coupled to the compressor or source of compressed gas, gas flows into chamber **103** and through openings **104**, mixes with crosslinkable solutions in supply lines **99** and **101**, and exits from openings **98** and **100** of distal tip **113**. As the gas-solution mixtures emerge from openings **98** and **100**, they are further atomized and mixed, and directed onto the tissue to be coated. As a result of crosslinking, for example, induced by free radical or chemical crosslinking, the solutions form a film that adheres to the tissue to provide a therapeutic benefit.

[0066] Openings **98** and **100** are preferably arranged so that the atomized crosslinkable solutions converge to provide a spray containing a mixture of the crosslinkable solutions. Adjacent openings **98** and **100** extend beyond distal endface **110** of barrel **92**, to define gap **405**, which assists in preventing clogging of the openings. Also, distal tip **113** is an angled tip, with an angle of about 80 degrees being defined by openings **98**, **100**. The openings are separated from each other by a separation distance **36**, which reduces opportunities for the openings to be fouled by unwanted reaction of complements that flow through the openings.

[0067] In some embodiments, it is advantageous to reduce clogging of openings by placing the gas outlet around or near the openings for the compositions, and extending the conduits several millimeters beyond the gas outlet before terminating the conduits in the openings for the compositions. The gap between the openings and the gas flow outlet may be, e.g., between about 0.2 mm and about 10 mm; a person of ordinary skill in the arts will appreciate that all values and ranges within this range are contemplated, e.g., between about 0.25 mm and about 7.0 mm, and from about 0.5 mm to about 0.75 mm.

[0068] Referring to **FIG. 1**, for example, conduits **24** and **25** pass through gas flow outlets **21***a* and **21***b*. The distance between endface **28** of barrel **12** openings **20***a* or **20***b* defines a gap **402**. The distance of gap **402** may be, e.g., between about 0.50 mm and about 0.75 mm, or about 0.10 mm and about 2.5 mm. Any amount of gap results in a reduction of surface tension that holds the precursor to the distal tip; however, too much gap results in the airflow not effectively blowing the polymer off of the distal tip, and can result in problems such as occlusions or divergent streams emerging from partially blocked flow paths.

[0069] In an applicator such as a sprayer with a gas flow outlet disposed around or near the openings for the compositions that are dispensed, the gas flow rate may also affect the quality and mixing of the material formed from the compositions. A gas flow rate that is too high may result in a rush of gas that will blow the hydrogel from the target location, and a gas flow rate that is too low may result in the distal tip becoming occluded. As described below, e.g., Example 3, a gas flow rate may advantageously be controlled between about 0.2 to about 1.0 liters per minute. An

air flow rate of 0.6 liters per minute was particularly useful in mixing of the emergent fluids, producing a consistent material, and minimizing clogging at the distal tip.

[0070] Example 2 shows the results of experiments with various angled tips. The openings defined angles between 120 degrees and 60 degrees, with the lower angles being more effective. This result suggests that angles of less than 120 degrees are desirable in the particular devices that were tested. In other embodiments, however, variations in the relevant flow rates and relative positions of the openings and/or outlets relative to each other may be expected to be effective at angles of more than 120 degree. Thus, angles of less than, e.g., 180, 160, 140, 130, and 120 degrees are contemplated.

[0071] **FIG. 5** shows embodiments of an angled tip as described herein. **FIG. 5A** shows angled tip **450** having adjacent conduits **452**, **454**, terminating in exit openings **456**, **458**, respectively, that are fitted with planes **460**, **462**, that intersect to define angle **464**, which is about 90 degrees. Gap **466** is defined between opening **456** and end of barrel **468**. Element **36** points to the separation distance between the openings. **FIG. 5B** shows angled tip **470** having adjacent conduits **472**, **474**, terminating in exit openings **476**, **478**, respectively, that are fitted with planes **480**, **482**, that intersect to define angle **484**, which is about 100 degrees. Gap **486** is defined between opening **478** and end of barrel **488**. Element **36** points to the separation distance between the openings.

[0072] Referring to **FIGS. 6A and 6B**, the distal tip **500** has an angled portion **502** with conduits **504**, **506** that terminate in exit openings **508**, **510**, respectively, that define angle **511**, which is depicted as being about 90 degrees. Sheath **512** encompasses conduits **504**, **506**, to define gas outlet **514**. Gap **516** is disposed between end of sheath **512** and openings **508** or **510**. The first exit opening is the terminus of a first conduit, the second exit opening is the terminus of a second conduit, a sheath surrounds at least a portion of the first conduit and the second conduit, and the gas flow outlet is defined by the space(s) between first opening, the second opening, and an opening of the sheath through which the first conduit and the second conduit pass. The sheath may be any mechanically suitable material, e.g., a flexible plastic tubing that fits snugly around the conduits.

[0073] The applicators can be made for bending of the conduits, either by a user or pre-bent at the point of manufacture. The conduits and sheath may be made of bendable material that is bendable without collapsing or kinking the conduits. For example, conduits **504** and **506** may be fabricated from a stiff yet bendable material such as PEEK or nylon and sheath **512** may be fabricated from a flexible polymer such as silicone, so that conduits **504** and **506** may be bent to certain angles and retain the bend angle without collapse of the conduits. Bending the conduits can facilitate access to target tissue in hard to reach places of the body. A variety of materials are available so that the lumen of the conduit remains open when the conduits are bent to angles up to 90°. The sprayer may be made to keep the conduits substantially parallel along the gap distance and for some distance inside the sheath so as to promote smooth air flow exiting the tip of the sprayer.

[0074] Further, a separation distance between openings may be used to reduce clogging of the openings. The separation distance is the shortest distance between the two closest portions of the two openings. For instance, two openings each have a circumference, and the shortest distance between them would be a shortest distance between any point on one circumference and any point on the other circumference. The separation distance may be, e.g., less than about 4 mm; a person of ordinary skill in the arts will appreciate that all values and ranges within 0 and 4 mm are contemplated. A smaller separation distance, however, facilitates mixing of components exiting the openings. Referring to **FIGS. 6A, 6B**, and **6**C, keeping spacing **503** to a minimum, and preferably at zero, facilitates mixing of the hydrogel components. If spacing, **503**, becomes too large, the components of the hydrogel are pushed away from each other in the gas emanating from gas outlet **514** and do not mix well.

[0075] Alternatively, the flow of gas between the openings may be reduced to enhance mixing of components flowing from the openings. One approach is to block the flow of gas in the space between the openings. One approach is to shape the gas flow outlets so that the flow of gas from the outlets is minimized in the area between the openings. Another approach is to introduce a bridge, or other piece that fits into the area between the openings to fully or partially block flow in that area. As shown in **FIG. 6C**, one-piece bridge **505** is placed between openings **508** and **510**. Mixing is enhanced due to a region of low pressure between openings **508** and **510** created as gas exits gas outlet **514**. The hydrogel components are drawn towards the low-pressure region, and thus towards each other, promoting mixing. Further, gas flowing from gas outlet **514** around bridge **505** will tend to push the components towards each other as they exit from openings **508** and **510**. In some embodiments, there is essentially no gas flowing in the area between the openings and the area has no openings allowing gas flow, e.g., as in **FIG. 6C**.

[0076] The size and shape of the gas flow outlet may be varied to control the spray pattern and the mixing of the hydrogel components. One process for making the gas flow outlets is to extrude or fit the sheath around the conduits. In this process, spacers may be used to control the dimensions of the gas conduit. For example, referring to **FIG. 6C**, the width of gas outlet **514** may be varied through the use of spacers, **509**, extruded along the outside of conduits **504** and **506**, and along bridge **505**.

[0077] The components of the applicator that are exposed to the precursors may be made from materials that are not adhesive for the precursors. For example, fabricating the sheath, **512**, from a hydrophobic material such as silicone is additionally beneficial to the objective of preventing clogging of the sprayer as many biomaterials and especially hydrogels will not adhere to silicone.

Hydrogel Systems for Use in an Applicator

[0078] Crosslinkable solutions preferred for use in accordance with the principles of the present invention include those that may be used to form coatings on tissue, and may form physical crosslinks, chemical crosslinks, or both. Physical crosslinks may result from complexation, hydrogen bonding, desolvation, Van der Waals interactions, ionic bonding, etc., and may be initiated by mixing two compo-

nents that are physically separated until combined in situ, or as a consequence of a prevalent condition in the physiological environment, such as temperature, pH, ionic strength, etc. Chemical crosslinking may be accomplished by any of a number of mechanisms, including free radical polymerization, condensation polymerization, anionic or cationic polymerization, step growth polymerization, etc.

[0079] Hydrogels suitable for use in accordance with the principles of the present invention preferably crosslink spontaneously without requiring the use of a separate energy source. Such systems allow good control of the crosslinking process, because gelation does not occur until the sprayer is actuated and mixing of the two solutions takes place. If desired, one or both crosslinkable solutions may contain dyes or other means for visualizing the hydrogel coating. Alternatively, a colored compound may be produced as a byproduct of the reactive process. The crosslinkable solutions also may contain a bioactive drug or therapeutic compound that is entrapped in the resulting coating, so that the coating becomes a drug delivery layer.

[0080] Properties of the hydrogel system, other than crosslinkability, preferably should be selected according to the intended application. For example, if the sprayer is to be used to provide a tissue adherent coating in the abdominal cavity to prevent post-surgical tissue adhesion, it is preferable that the hydrogel system have a relatively low tensile strength, to avoid adversely effecting normal physiologic processes of the organs, be near equilibrium hydration when formed, experience relatively little in situ swelling, and be biodegradable.

[0081] Other applications may require different characteristics of the hydrogel system. There is extensive literature describing the formulation of crosslinkable coating materials for particular medical applications, which formulae may be readily adapted for use herein with little experimentation. More generally, for example, if a hydrogel system is to be used for coating of tissues, cells, medical devices, or capsules, for drug delivery or as mechanical barriers or supports, the materials should be selected on the basis of exhibited biocompatibility and lack of toxicity. For all biologically-related uses, toxicity must be low or absent in the finished state for externally coated non-living materials, and at all stages for internally-applied materials.

[0082] Additionally, the hydrogel system solutions should not contain harmful or toxic solvents. Preferably, the solutions are substantially soluble in water to allow application in a physiologically-compatible solution, such as buffered isotonic saline. Water-soluble coatings may form thin films, but more preferably form three-dimensional gels of controlled thickness. It is also preferable in cases that the coating be biodegradable, so that it does not have to be retrieved from the body. Biodegradability, as used herein, refers to the predictable disintegration of the coating into molecules small enough to be metabolized or excreted under normal physiological conditions.

Polymers Suitable for Physical Crosslinking

[0083] Physical crosslinking may be intramolecular or intermolecular or in some cases, both. For example, hydrogels can be formed by the ionic interaction of divalent cationic metal ions (such as Ca+2 and Mg+2) with ionic polysaccharides such as alginates, xanthan gums, natural gum, agar, agarose, carrageenan, fucoidan, furcellaran, laminaran, hypnea, eucheuma, gum arabic, gum ghatti, gum karaya, gum tragacanth, locust beam gum, arabinogalactan, pectin, and amylopectin. These crosslinks may be easily reversed by exposure to species that chelate the crosslinking metal ions, for example, ethylene diamine tetraacetic acid. Multifunctional cationic polymers, such as poly(1-lysine), poly(allylamine), poly(ethyleneimine), poly(guanidine), poly(vinyl amine), which contain a plurality of amine functionalities along the backbone, may be used to further induce ionic crosslinks.

[0084] Hydrophobic interactions are often able to induce physical entanglement, especially in polymers, that induces increases in viscosity, precipitation, or gelation of polymeric solutions. For example, poly(oxyethylene)-poly(oxypropylene) block copolymers, available under the trade name of PLURONIC, BASF Corporation, Mount Olive, N.J., are well known to exhibit a thermoreversible behavior in solution. Thus, an aqueous solution of 30% PLURONIC F-127 is a relatively low viscosity liquid at 4 degree C. and forms a pasty gel at physiological temperatures due to hydrophobic interactions. Other block and graft copolymers of water soluble and insoluble polymers exhibit similar effects, for example, copolymers of poly(oxyethylene) with poly(styrene), poly(caprolactone), poly(butadiene) etc.

[0085] Techniques to tailor the transition temperature, i.e., the temperature at which an aqueous solution transitions to a gel due to physical linking, are per se known. For example, the transition temperature may be lowered by increasing the degree of polymerization of the hydrophobic grafted chain or block relative to the hydrophilic block. Increase in the overall polymeric molecular weight, while keeping the hydrophilic: lipophilic ratio unchanged also leads to a lower gel transition temperature, because the polymeric chains entangle more effectively. Gels likewise may be obtained at lower relative concentrations compared to polymers with lower molecular weights.

[0086] Solutions of other synthetic polymers such as poly(N-alkylacrylamides) also form hydrogels that exhibit thermoreversible behavior and exhibit weak physical crosslinks on warming. During spraying of thermoreversible solutions, cooling of the solutions may be expected from evaporation during atomization. Upon contact with tissue target at physiological temperatures, viscosity is expected to increase from the formation of physical crosslinks. Similarly, pH responsive polymers that have a low viscosity at acidic or basic pH may be employed, and exhibit an increase in viscosity upon reaching neutral pH, for example, due to decreased solubility.

[0087] For example, polyanionic polymers such as poly(acrylic acid) or poly(methacrylic acid) possess a low viscosity at acidic pHs that increases as the polymers become more solvated at higher pHs. The solubility and gelation of such polymers further may be controlled by interaction with other water soluble polymers that complex with the polyanionic polymers. For example, it is well known that poly(ethylene oxides) of molecular weight over 2,000 dissolve to form clear solutions in water. When these solutions are mixed with similar clear solutions of poly(methacrylic acid) or poly(acrylic acid), however, thickening, gelation, or precipitation occurs depending on the particular pH and conditions used (for example see Smith et al., "Association

reactions for poly(alkylene oxides) and poly(carboxylic acids)," Ind. Eng. Chem., 51:1361 (1959). Thus, a two component aqueous solution system may be selected so that the first component (among other components) consists of poly(acrylic acid) or poly(methacrylic acid) at an elevated pH of around 8-9 and the other component consists of (among other components) a solution of poly(ethylene glycol) at an acidic pH, such that the two solutions on being combined in situ result in an immediate increase in viscosity due to physical crosslinking.

[0088] Physical gelation also may be obtained in several naturally existing polymers too. For example gelatin, which is a hydrolyzed form of collagen, one of the most common physiologically occurring polymers, gels by forming physical crosslinks when cooled from an elevated temperature. Other natural polymers, such as glycosaminoglycans, e.g., hyaluronic acid, contain both anionic and cationic functional groups along each polymeric chain. This allows the formation of both intramolecular as well as intermolecular ionic crosslinks, and is responsible for the thixotropic (or shear thinning) nature of hyaluronic acid. The crosslinks are temporarily disrupted during shear, leading to low apparent viscosities and flow, and reform on the removal of shear, thereby causing the gel to reform.

Macromers for Covalent Crosslinking

[0089] Water soluble polymerizable polymeric monomers having a functionality >1 (i.e., that form crosslinked networks on polymerization) and that form hydrogels are referred to hereinafter as "macromers". Several functional groups may be used to facilitate chemical crosslinking reactions. When these functional groups are self condensible, such as ethylenically unsaturated functional groups, the crosslinker alone is sufficient to result in the formation of a hydrogel, when polymerization is initiated with appropriate agents. Where two solutions are employed, each solution preferably contains one component of a co-initiating system and crosslink on contact. The solutions are stored in separate compartments of a sprayer, and mix either when sprayed or on contact with the tissue.

[0090] An example of an initiating system suitable for use in the present invention is the combination of a peroxygen compound in one solution, and a reactive ion, such as a transition metal, in another. Other means for polymerization of macromers to coatings on tissue also may be advantageously used with macromers that contain groups that demonstrate activity towards functional groups such as amines, imines, thiols, carboxyls, isocyanates, urethanes, amides, thiocyanates, hydroxyls, etc., which may be naturally present in, on, or around tissue. Alternatively, such functional groups optionally may be provided in the region as part of the instilled formulation required to effect the barrier. In this case, no external initiators of polymerization are needed and polymerization proceeds spontaneously when two complementary reactive functional groups containing moieties interact at the application site.

[0091] Preferred hydrogel systems are those biocompatible multi-component systems that spontaneously crosslink when the components are mixed, but wherein the two or more components are individually stable for the duration of the deposition process. Such systems include, for example, contain macromers that are di or multifunctional amines in one component and di or multifunctional oxirane containing moieties in the other component. Other initiator systems, such as components of redox type initiators, also may be used. The mixing of the two or more solutions may result in either an addition or condensation polymerization that further leads to the formation of a coating.

[0092] Any monomer capable of being crosslinked to form a biocompatible surface coating may be used. The monomers may be small molecules, such as acrylic acid or vinyl caprolactam, larger molecules containing polymerizable groups, such as acrylate-capped polyethylene glycol (PEG-diacrylate), or other polymers containing ethylenically-unsaturated groups, such as those of U.S. Pat. No. 4,938,763 to Dunn et al, U.S. Pat. Nos. 5,100,992 and 4,826,945 to Cohn et al, U.S. Pat. Nos. 4,741,872 and 5,160,745 to De Luca et al., or U.S. Pat. No. 5,410,016 to Hubbell et al.

[0093] Some useful monomers are the crosslinkable, biodegradable, water-soluble macromers described in U.S. Pat. No. 5,410,016 to Hubbell et al, which is incorporated herein by reference. These monomers are characterized by having at least two polymerizable groups, separated by at least one degradable region. When polymerized in water, they form coherent gels that persist until eliminated by self-degradation. In one embodiment, the macromer is formed with a core of a polymer that is water soluble and biocompatible, such as the polyalkylene oxide polyethylene glycol, flanked by hydroxy acids such as lactic acid, having acrylate groups coupled thereto. Preferred monomers, in addition to being biodegradable, biocompatible, and non-toxic, also will be at least somewhat elastic after polymerization or curing.

[0094] It has been determined that monomers with longer distances between crosslinks are generally softer, more compliant, and more elastic. Thus, in the polymers of Hubbell, et al., increased length of the water-soluble segment, such as polyethylene glycol, tends to enhance elasticity. Molecular weights in the range of 10,000 to 35,000 of polyethylene glycol are preferred for such applications, although ranges from 3,000 to 100,000 also are useful.

[0095] In addition, coatings formed in accordance with the methods of the present invention may be formed as laminates (i.e., having multiple layers). Thus, for example, a lower layer of the laminate may consist of a more tightly crosslinked hydrogel that provides good adherence to the tissue surface and serves as a substrate for an overlying compliant coating to reactively bond thereto. Materials having lower molecular weights between crosslinks may be suitable for use as a base coating layer. Molecular weights in the range of 400 to 20,000 of polyethylene glycol are preferred for such applications, although ranges from 400 to 10,000 are more preferable.

[0096] It should be understood, however, that hydrogels that crosslink by a variety of other mechanisms, for example, by interaction of electrophilic and nucleophilic functional groups, also may be advantageously used in accordance with the principles of the present invention.

Initiating Systems

[0097] Metal ions may be used either as an oxidizer or a reductant in redox initiating systems. For example, in the Example set forth hereinbelow, ferrous ions are used in combination with a peroxide or hydroperoxide to initiate polymerization, or as parts of a polymerization system. In

this case, the ferrous ions serve as a reductant. In other previously known initiating systems, metal ions serve as an oxidant.

[0098] For example, the ceric ion (4+ valence state of cerium) interacts with various organic groups, including carboxylic acids and urethanes, to remove an electron to the metal ion, and leave an initiating radical behind on the organic group. In such a system, the metal ion acts as an oxidizer. Potentially suitable metal ions for either role are any of the transition metal ions, lanthanides and actinides, which have at least two readily accessible oxidation states.

[0099] Preferred metal ions have at least two states separated by only one difference in charge. Of these, the most commonly used are ferric/ferrous; cupric/cuprous; ceric/cerous; cobaltic/cobaltous; vanadate V vs. IV; permanganate; and manganic/manganous. Peroxygen containing compounds, such as peroxides and hydroperoxides, including hydrogen peroxide, t-butyl hydroperoxide, t-butyl peroxide, benzoyl peroxide, cumyl peroxide, etc., may be used.

[0100] Thermal initiating systems may be used rather than the redox-type systems described hereinabove. Several commercially available low temperature free radical initiators, such as V-044, available from Wako Chemicals USA, Inc., Richmond, Va., may be used to initiate free radical crosslinking reactions at body temperatures to form hydrogel coatings with the aforementioned monomers.

[0101] Macromers for use in forming tissue coatings using the apparatus of the present invention include any of a variety of in situ crosslinkable macromers that form hydrogel compositions in vivo. These macromers may, for example, be selected from compositions that are biodegradable, crosslinkable, and substantially water soluble macromers comprising at least one water soluble region, at least one degradable region, and statistically more than 1 polymerizable region on average per macromer chain, wherein the polymerizable regions are separated from each other by at least one degradable region. Alternatively, if biodegradability is not desirable, compositions that do not contain the biodegradable segments but are substantially water soluble and crosslink in vivo under acceptable physiological conditions may be used.

[0102] Preferred compositions for use with devices as described herein are sold by CONFLUENT SURGICAL, INC., under the trademarks DURASEAL or SPRAYGEL.

Incorporation by Reference

[0103] Additional disclosure are set forth in commonly owned and assigned patents, including: U.S. Pat. No. 6,610,033 entitled "Dual Component Medicinal Polymer Delivery System and Methods of Use," U.S. Pat. No. 6,632,457 entitled "Composite Hydrogel Drug Delivery Systems," U.S. Pat. No. 6,566,406 entitled "Biocompatible Crosslinked Polymers," U.S. Pat. No. 6,179,862 entitled "Methods and Apparatus for In Situ Formation of Hydrogels," U.S. Pat. No. 6,165,201 entitled "Methods and Apparatus for In Situ Formation of Hydrogels," U.S. Pat. No. 6,673,093 entitled "Methods and Apparatus for In Situ Formation of Hydrogels," U.S. Pat. No. 6,152,943 entitled "Methods and Apparatus for Intraluminal Deposition of Hydrogels," U.S. Pat. No. 6,379,373 entitled "Methods and Apparatus for Intraluminal Deposition of Hydrogels," U.S. Pat. No. 6,689,148 entitled "Methods and Apparatus for Intraluminal Deposition of Hydrogels," U.S. Pat. No. 6,605,294 entitled "Methods of Using In Situ Hydration of Hydrogel Articles for Sealing of Augmentation of Tissue or Vessels," U.S. Pat. No. 6,514,534 entitled "Methods for Forming Regional Tissue Adherent Barriers and Drug Delivery Systems," and patent application Ser. Nos. 09/133,940; 10/639,700 entitled "Composite Hydrogel Drug Delivery Systems," Ser. No. 10/373,939 entitled "Biocompatible Crosslinked Polymers," Ser. No. 10/373,269 entitled "Biocompatible Crosslinked Polymers," Ser. No. 09/776,120 entitled "Dehydrated Hydrogel Precursor-Based, Tissue Adherent Compositions and Methods of Use," Ser. Nos. 09/147,897, 10/068,807 entitled "Crosslinking Agents and Methods of Use," Ser. No. 10/293,453 entitled "Proteinaceous Gels Having Visualization Agents and Methods of Use Thereof," Ser. No. 10/364,592 entitled "Crosslinked Albumin Hydrogels," Ser. No. 10/319,308 entitled "Adhesion Barriers Applicable By Minimally Invasive Surgery and Methods of Use Thereof," Ser. No. 10/756,181 entitled "Methods and Apparatus for Intraluminal Deposition of Hydrogels," Ser. No. 10/616,055 entitled "Methods of Using In Situ Hydration of Hydrogel Articles for Sealing or Augmentation of Tissue or Vessels," Ser. No. 10/266,980 entitled "Methods for Forming Regional Tissue Adherent Barriers And Drug Delivery Systems," and Ser. No. 10/010,715 entitled "Biocompatible Crosslinked Polymers", each of which are hereby incorporated by reference herein. These applications include, among other things, descriptions of components that may be used in the applicators described herein, e.g., including precursors for forming a hydrogel.

EXAMPLES

Example 1

[0104] Sprayer **10** of **FIG. 1** is used in conjunction with aqueous solutions of crosslinkable monomers. Solution **1**, consisting of a 10% solution of a polyethylene glycol diacrylate (M.W. 3,000 Da, purchased from Shearwater Polymers, Huntsville, Ala.) dissolved in normal saline (pH 5-6) and containing 500 ppm of hydrogen peroxide is drawn up in syringe **13**, preferably a 5 cc syringe. Solution **2**, consisting of a 10% solution of a polyethylene glycol diacrylate dissolved in normal saline (pH 5-6) and containing 5000 ppm of ferrous sulfate peroxide, is drawn up in syringe **14**, also a 5 cc syringe. Syringes **13** and **14** are individually loaded in compartments **23**, and are coupled to conduits **24** and **25** and actuator **15**.

[0105] Airflow from a regulated source of compressed air (an air compressor such as those commercially available for airbrushes) is connected to the sprayer **10** using a piece of tubing. When actuator **15** is depressed, a steady spray of the two liquid components will be observed. When this spray is directed to a piece of tissue a hydrogel coating will be observed to form on the surface of the tissue. The hydrogel coating is resistant to rinsing and is well adhered to the tissue surface. Within a short period of time (less than a minute) an area of 10 cm. times 5 cm may be coated with ease.

Example 2

[0106] A sprayer as in sprayer **10** of **FIG. 1** was mounted in a rigid system in a horizontal position for a horizontal spray test. The sprayer was essentially identical to sprayer **10**, except that the gas flow outlets and conduits were

arranged as depicted in **FIG. 6A, 6B**. The angle **511**, and was about 90 degrees, sheath **512** was made of plastic, and encompassed conduits **504**, **506**, to define gas outlet **514**. Gap **516** was about 0.7 mm.

[**0107**] The tip of each sprayer was a distance of 2 cm from the target location, a vertical mylar sheet. In each of the syringes **13** and **14** was placed 1 mL of DuraSeal® sealant. Plungers **26** were depressed to dispense 0.2 mL (0.1 mL per syringe). The sprayer **10** was left to stand for 30 seconds. Then an additional 0.2 mL (0.1 mL per syringe) increment was delivered. This was repeated until the entire polymer was delivered in 0.2 mL increments with 30 seconds of standing between each application. The same procedure was followed for sprayer **10** that contained a straight or flat surface distal tip and for sprayer **10** that contained an angled shape distal tip (90 degrees).

[**0108**] After each increment application, the sprayer **10** was rated using a scoring system to determine the function with respect to clogging. The scoring system was: (1) near perfect (good spray/good gel quality); (2) slight plugging (can be unplugged and continue working by depressing syringes); (3) divergent streams; and (4) one or more openings **20***a* or **20***b* of distal tip **20** occluded. The results of this test were graphed as illustrated in **FIGS. 7A and 7B**.

[**0109**] The angle between the openings on the angle tip was further adjusted to determine what angles would be most suitable. A sprayer was tested at a variety of flow rates with different angles of 60, 90, and 120 degrees. The 120 degree angle had some difficulties with clogging. The 60 and 90 degree angles performed well, and were similar in effectiveness.

Example 3

[**0110**] Sprayers were tested to determine the air flow required to achieve both good mixing and good material formation from the compositions. Sprayers as in Example 2 were mounted vertically in a rigid fixture suspended 4 cm form a target of mylar. The sprayers were connected to an air source with a regulator, and the mass flow of the air was adjusted to range between 0.2 to 1.0 liters/minute. A total volume of 0.4 ml of the material formed from the precursors was deposited on the target at each flow rate. The pattern of material formed on the target was observed. At 1.0 l/min, the material was deposited in a volcano-shape, i.e., a circle with relatively more material deposited around the edges of the circle. At rates below 0.4 l/minute, the applicator tended to clog. The 0.6 ml/minute rate made a pattern that was relatively more consistent in thickness and quality compared to 0.8 ml/minute rate, which showed a more significant volcano effect.

[**0111**] All patents, publications, and journal articles set forth herein are hereby incorporated by reference herein.

We claim:

1. A medical apparatus for applying a biocompatible coating in situ comprising:

a first conduit connected to a first exit opening and a second conduit connected to a second exit opening to deliver a first composition through the first conduit and a second composition through the second conduit to mix the first composition and the second composition outside both the first conduit and the second conduit,

wherein the first composition comprises a precursor to a material formed after the mixing of the first composition and the second composition,

wherein the first exit opening and the second exit opening are approximately adjacent to each other and define an angle that is less than about 140 degrees.

2. The apparatus of claim 1, wherein the angle is between about 120 degrees and about 30 degrees.

3. The apparatus of claim 1, further comprising a gas flow outlet associated with at least one of the first exit opening and the second exit opening for flowing gas to dispense at least the first composition.

4. The apparatus of claim 3, further comprising a third conduit in fluid communication with the gas flow outlet.

5. The apparatus of claim 4, wherein a gas exiting the gas flow outlet propels the first component out of the first opening.

6. The apparatus of claim 4, wherein the third conduit is in further fluid communication with a gas compressor or a compressed, a gas cylinder, or a gas inlet port.

7. The apparatus of claim 4, wherein the first conduit passes through the gas flow outlet.

8. The apparatus of claim 4, wherein the first conduit and second conduit pass through the gas flow outlet.

9. The apparatus of claim 11, wherein a gas exiting the gas flow outlet propels the first and second components out of the first and second openings, respectively.

10. The apparatus of claim 4, further comprising a gap having a length defined by a shortest distance separating the gas flow outlet from the first opening.

11. The apparatus of claim 13, wherein the length of the gap is between about 0.1 mm and about 7 mm.

12. The apparatus of claim 1, further comprising a vent hole for venting excess pressure within the tissue cavity.

13. The apparatus of claim 1, further comprising a first chamber fluidly connected to the first conduit and a second chamber fluidly connected to the second conduit.

14. The apparatus of claim 19, wherein the first chamber is detachably coupled to the first conduit.

15. The apparatus of claim 1, further comprising means for regulating a rate at which the first composition and the second composition flow from the first and second exit openings, respectively.

16. The apparatus of claim 1, wherein the first opening and the second opening are adjacent to a gas flow outlet.

17. The apparatus of claim 16, wherein the gas flow outlet surrounds at least the first opening.

18. The apparatus of claim 16, wherein the first opening is the terminus of a first conduit, the second opening is the terminus of a second conduit, a sheath surrounds at least a portion of the first conduit and the second conduit, and the gas flow outlet is defined by the space(s) between first opening, the second opening, and an opening of the sheath through which the first conduit and the second conduit pass.

19. The apparatus of claim 1, wherein the angle defines the distal tip of the apparatus.

20. The apparatus of claim 1, wherein the first exit opening and second exit opening are each disposed on a curved surface.

21. A method for applying a biocompatible material in situ in a patient comprising using an apparatus to apply a first composition and a second composition to react the first composition with the second composition to thereby form the biocompatible material in situ:

wherein the apparatus comprises a first conduit connected to a first exit opening and a second conduit connected to a second exit opening to deliver the first composition through the first conduit and the second composition through the second conduit to mix the first composition and the second composition outside both the first conduit and the second conduit, with the first exit opening and the second exit opening being approximately adjacent to each other and defining an angle that is less than about 120 degrees; and,

wherein the first composition comprises a precursor to the material formed after the mixing of the first composition and the second composition.

22. The method of claim 21, wherein applying the first composition from the first conduit and applying the second composition from the second conduit occurs approximately simultaneously.

23. The method of claim 21, wherein the first composition and the second composition each comprise a precursor that crosslinks with the other precursor by a covalent crosslinking process.

24. The method of claim 21, wherein the material is deposited to form a barrier that reduces leakage of body fluids.

25. The method of claim 21, wherein the material is deposited to form a barrier that reduces formation of post-surgical adhesions.

26. The method of claim 21, further comprising forming the material on a tissue surface with biologically-active therapeutic materials mixed in the material.

27. The method of claim 21, wherein the apparatus is a sprayer for spraying the first composition and the second composition.

28. The method of claim 21, wherein the apparatus further comprises means for regulating a rate at which the first composition and the second composition flow from the first and second exit openings, respectively.

29. The method of claim 21, wherein the first exit opening and the second exit opening are adjacent to a gas flow outlet.

30. The method of claim 29, wherein the gas flow outlet surrounds at least the first opening.

31. The method of claim 29, wherein the first opening is the terminus of a first conduit, the second opening is the terminus of a second conduit, a sheath surrounds at least a portion of the first conduit and the second conduit, and the gas flow outlet is defined by the space(s) between first opening, the second opening, and an opening of the sheath through which the first conduit and the second conduit pass.

32. The method of claim 31, wherein gas flows from the gas outlet at between about 0.2 and about 1.0 liters per minute.

* * * * *

EXHIBIT 4

PATENT
Atty. Docket No. H-US-01208 CON (1603-51 CON)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Les Hull	Examiner:	Darren W. Gorman
Serial No.:	13/493,207	Group:	Art Unit: 3752
Filed:	June 11, 2012	Dated:	July 23, 2013
For:	**SPRAY APPLICATOR**		

Filed Via EFS-Web
Confirmation No.: 3152

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT UNDER 37 CFR §1.116

In response to the Final Office Action dated May 28, 2013, please reconsider the application in view of the following amendments and remarks.

AMENDMENTS TO THE CLAIMS begin on page 2 of this paper.

REMARKS begin on page 5 of this paper.

CERTIFICATE OF ELECTRONIC FILING UNDER 37 C.F.R. §1.6(a)(4)
I hereby certify that this correspondence is being transmitted on the date below with the United States Patent and Trademark Office, PO Box 1450, Alexandria, VA 22313-1450, via electronic submission.

Dated: July 23, 2013

Adrienne Fagan

AMENDMENT TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application:

1-7. (Canceled)

8. (Currently amended) A spray assembly for dispensing a mixture, the assembly comprising:

a connector configured for operable engagement with a first source of component and a second source of component;

an elongated member operably connected to and extending distally from the connector, the elongated member including an inner shaft and an outer sleeve, and defining a vent lumen between the inner shaft and outer sleeve, the inner shaft defines at least a first lumen configured for fluid communication with the first source of component and a second lumen configured for fluid communication with the second source of component;

a tip operably connected to the connector, the tip including an opening and defining a mixing chamber between a distal end of the elongated member and the opening of the tip; and

an insert member configured to be received in the mixing chamber, the insert member defining at least one radially extending slot on a first end of the insert member and at least one radially extending slot on a second end of the insert member, each of the radially extending slots being configured to mix the first and second components prior to the combination exiting the opening in the tip.

9. (Previously presented) The spray assembly of claim 8, further including a first and a second source of component.

10. (Previously presented) The spray assembly of claim 8, wherein the insert member includes three slots formed on the first end.

11. (Previously presented) The spray assembly of claim 8, wherein the at least one radially extending slot on the first end of the insert includes a plurality of slots.

12. (Previously presented) The spray assembly of claim 8, wherein the at least one radially extending slot on the second end of the insert includes a plurality of slots.

13-14. (Canceled)

15. (Currently amended) The spray assembly of claim 8 [[13]], wherein the outer sleeve includes at least one lateral opening in a proximal end thereof and at least one lateral opening in a distal end thereof.

16. (Currently amended) The spray assembly of claim 8 [[13]], wherein the elongated member includes a formable member extending substantially the length thereof to permit forming of the inner shaft.

17. (Previously presented) The spray assembly of claim 8, further including a transition member operably connecting the elongated member and the tip.

18. (Previously presented) The spray assembly of claim 8, wherein the insert member includes a plurality of spacers extending longitudinally along substantially the length thereof.

19. (Previously presented) The spray assembly of claim 8, wherein the insert member further defines an annular recess on each of the first and second ends of the insert member.

20. (Previously presented) The spray assembly of claim 19, wherein the at least one radially extending slot in each of the first and second ends is formed between a line tangent to the respective annular recess and a line α degrees counter-clockwise from the tangent line.

21. (Previously presented) The spray assembly of claim 20, wherein α is about twenty degrees.

22. (Previously presented) The spray assembly of claim 8, wherein a distal end of the elongated body abuts the first end of the insert.

23. (New) The spray assembly of claim 8, wherein the outer sleeve includes a plurality of lateral openings formed in the distal end.

REMARKS

The above-referenced application has been reviewed in light of the Final Office Action dated May 28, 2013. By the present amendment, Applicant has amended Claims 8 and 15, added new Claim 23, and canceled Claims 13 and 14. It is respectfully submitted that Claims 8-12 and 15-23, are fully supported by the specification, the present amendment introduces no new matter, and the claims are allowable over the cited art of record. Entry of this amendment and favorable reconsideration of these claims are earnestly sought.

A. Double Patenting

Claims 8-12 stand rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over Claims 1-5 of U.S. Patent No. 8,210,453. Applicants respectfully submit that, if upon indication that Claims 8-12 are otherwise allowable, a terminal disclaimer is still required that one will be submitted in accordance with 37 C.F.R. § 1.321(c) or 1.321(d) will be filed.

B. Rejections Under 35 U.S.C. § 103

Claims 8-12 and 19-22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,605,255 to Reidel et al. ("Reidel") in view of U.S. Patent Application Publication No. 2008/0121738 to Togashi ("Togashi").

Applicant respectfully submits that Reidel and Togashi, taken alone or in any proper combination, do not teach or suggest all the limitations of amended independent Claim 8. In particular, the combination of Reidel in view of Togashi does not disclose or suggest a spray assembly, *inter alia*, an elongated member including "an inner shaft and an outer sleeve and

defining a vent lumen between the inner shaft and outer sleeve," as presently recited in independent Claim 8.

With reference to FIG. 1 of Reidel, reproduced below, Reidel discloses an "apparatus suitable for spraying, and where appropriate applying to a surface, two liquids as mixture" (Abstract). As noted by the Examiner, the apparatus includes an "elongated member including at least a first lumen (ZK1; see Figures 2 and 3) configured for fluid communication with the first source of component and a second lumen (ZK2; see Figures 2 and 3) configured for fluid communication with the second source of component." (Page 3, line 24- page 4, line 3).

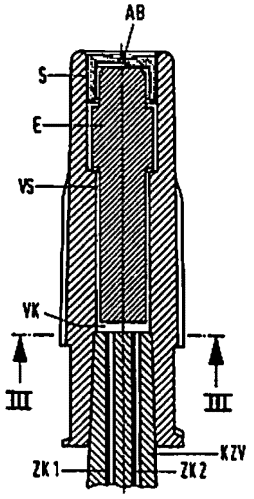

FIG.2

With reference to FIG. 2 of Togashi, reproduced below, Togashi discloses a spray nozzle mechanism. The spray nozzle includes "[a] push button body 1, [a] nozzle piece 2, [a] core 3, and [a] stem 4. (Para. [0054]). As seen in FIG. 2, "the content flow passage from the stem 4 to the discharge hole 2*a* is the content passage of the stem 4-vertical passage 1*a* of the push button body 1-its output hole part 1*b*-upstream side recessed passage 1*e*-space region 2*f* of the color member 2-downstream side recessed passage 2*d*-circular recessed part 2*c*-discharge hole 2*a*." (Para. [0055]).

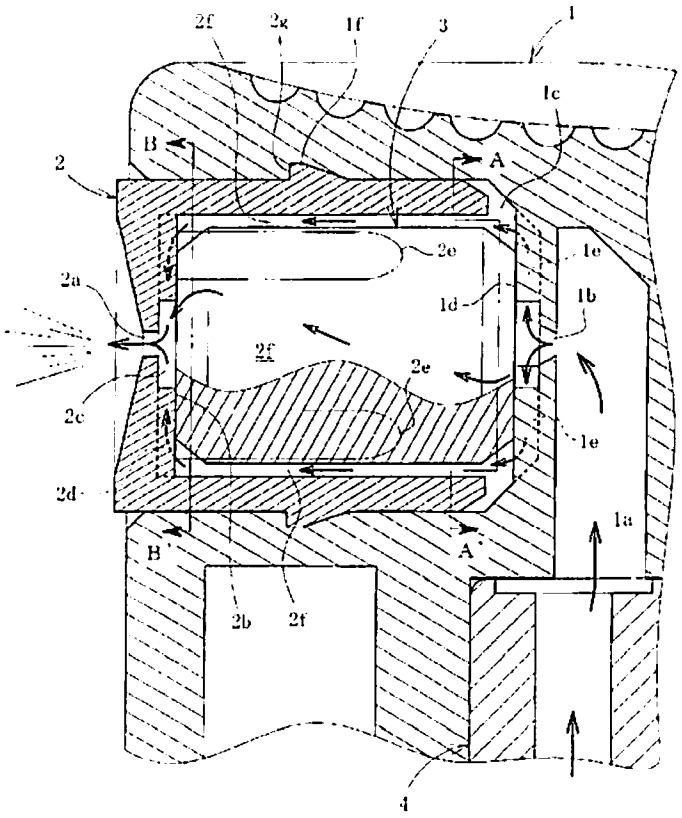

FIG 2

Clearly, neither the apparatus of Reidel nor the spray nozzle mechanism of Togashi includes an elongated body having an inner shaft and an outer sleeve, much less an elongated body defining vent lumen between an inner shaft and an outer sleeve, as presently recited in independent Claim 8.

For at least this reason, Applicant submits that the rejection of independent Claim 8 under 35 U.S.C. § 103(a) as being unpatentable over Reidel in view of Togashi, should be withdrawn and that independent Claim 8 is in condition for allowance. Since Claims 9-12 and 19-22 depend from independent Claim 8, and each contains all the features of Claim 8, for at least the same reasons, *inter alia*, Claim 8 is in condition for allowance, Claims 9-12 and 19-22 are also in condition for allowance.

Claims 8-15 and 17-22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over German Patent No. 295 16 077 to Maslanka ("Maslanka") in view of Reidel and Togashi. As noted above, by the present amendment, Claims 13 and 14 have been canceled. Accordingly, the rejection of Claims 13 and 14 is moot.

Applicant respectfully submits that Maslanka, Reidel, and Togashi, taken alone or in any proper combination, do not teach or suggest all the limitations of independent Claim 8. In particular, the combination of Maslanka, Reidel, and Togashi does not disclose or suggest a spray assembly for dispensing a mixture including, *inter alia*, an elongated member including "an inner shaft and an outer sleeve and defining a vent lumen between the inner shaft and outer sleeve, the inner shaft defines at least a first lumen ... and a second lumen," as presently recited in independent Claim 8.

With reference to FIG. 2 of Maslanka, reproduced below, according to the Examiner, Maslanka discloses "a spray assembly (see Figures 1-3) for spraying/dispensing a fine spray mixture of two components, the assembly comprising... an elongated member (12) operably connect to and extending distally from the connector, the elongated member including at least a first lumen (14) configured for fluid communication with the first source of component and a second lumen (16) configured for fluid communication with the second source of component." (Page 8, lines 3-9).

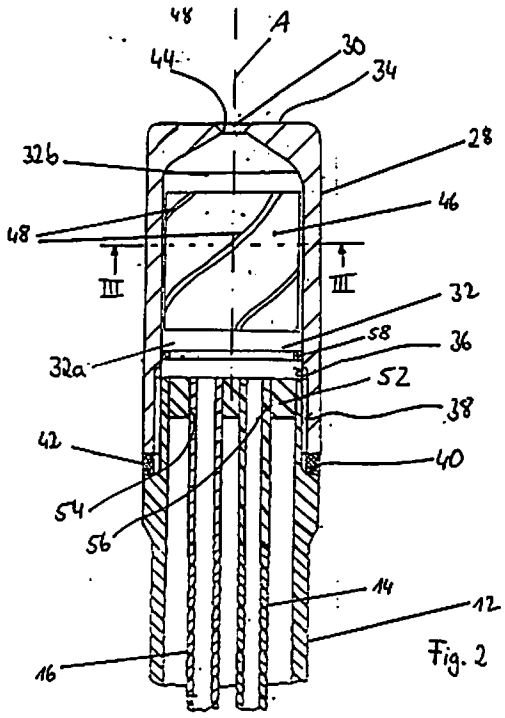

Fig. 2

Clearly, the applicator of Maslanka does not include an elongated body having an inner shaft and outer sleeve and defining a vent lumen therebetween. Further, the applicator of Maslanka does not disclose an inner shaft defining first and second lumen. Instead, as noted above, the applicator of Maslanka includes a pair of conduits. Further, despite the Examiner's assertion, the space between conduits 16 and the outer sleeve 12 does not define a vent lumen as claimed.

As demonstrated above, neither Reidel nor Togashi disclose an elongated body including an inner shaft and an outer sleeve and defining a vent lumen between the inner shaft and the outer sleeve.

For at least this reason, Applicant submits that the rejection of independent Claim 8 under 35 U.S.C. § 103(a) as being unpatentable over Maslanka in view of Reidel, and Togashi, should be withdrawn and that independent Claim 8 is in condition for allowance. Since Claims 9-12,

15, and 17-22 depend from independent Claim 8, and each contains all the features of Claim 8, for at least the same reasons, *inter alia*, Claim 8 is in condition for allowance, Claims 9-12, 15, and 17-22 are also in condition for allowance.

Claim 16 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Maslanka, as modified by Reidel and Togashi as applied above, and further in view of U.S. Patent No. 5,740,965 to Miyagi et al. ("Miyagi"). The Examiner relies on Miyagi to teach "a formable member (77) extending substantially the length of the elongated member." (Page 14, lines 6-7). Miyagi fails to provide any disclosure that, when taken in any proper combination with Maslanka, Reidel, and Togashi, discloses the surgical device of amended independent Claim 8. Since Claim 16 depends from Claim 8, for at least the reasons discussed above with respect to Claim 8, *inter alia*, Applicants also submit that Claim 16 is also patentable over Reidel, Togashi, and Miyagi.

C. New Claim

Applicant has added new Claim 23. Claim 23 depends from independent Claim 8. Applicant submits that Claim 23 is also patentable over Reidel, Togashi, Maslanka, and Miyagi for at least the reasons discussed above with respect to Claim 8.

Conclusion

In view of the foregoing, it is respectfully submitted that all claims presently pending in the application, namely Claims 8-12 and 15-23, are in condition for allowance. Should the Examiner believe that a telephone or personal interview may facilitate resolution of any remaining matters, the Examiner is respectfully requested to contact the representatives for the Applicants at the telephone number indicated below.

Please charge any deficiency as well as any other fee(s) which may become due under 37 C.F.R. §1.16 and/or 1.17 at any time during the pendency of this application, or credit any overpayment of such fee(s) to Deposit Account No. 21-0550. Also, in the event any extensions of time for responding are required for the pending application(s), please treat this paper as a petition to extend the time as required and charge Deposit Account No. 21-0550 therefor.

Respectfully submitted,

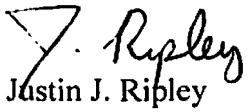

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EXHIBIT 5

(19) FEDERAL REPUBLIC OF GERMANY

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(12) Utility Model

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(51) Int. Cl.[6]:
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(54) Spray device

DE 295 16 077 U 1

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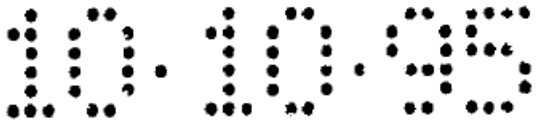
October 10, 1995

Spray device

The invention relates to a spray device for the application of a substance mixed from at least two components.

From the German Utility Model Specification G 86 23 423, an injection device for an endoscope is known, by means of which two-component substances, in particular two-component tissue adhesives, can be injected. The injection device comprises a guide tube which is to be introduced into the instrument channel of the endoscope, and in which two tube lines for supplying liquid components of the two-component tissue adhesive are slidably guided. On the distal end of the tube lines, a mixing head consisting of two head parts is attached. The mixing head contains a mixing chamber which is delimited by a blind hole in one of the head parts and by an attachment piece of the other head part. The tube lines flow only with partial overlap with the mixing chamber, so that the fluid components flow with a radial component into the mixing chamber. The head part carrying the attachment piece is firmly connected to an injection cannula and screwed to the other head part.

An injection cannula has also been disclosed. The injection cannula comprises an intermediate element which can be plugged by means of the proximal connection parts thereof onto a feed device, as well as a spray head



which can be attached to said intermediate element. In the intermediate element, channels are formed for the components to be mixed arriving from the feed device. The channels in the intermediate element extend toward one another first from a section of the intermediate element adjoining the feed device, and thereafter extend parallel in a section close to the spray head. In the distal section of the intermediate element, they lead into a mixing chamber secured by the spray head. A cylindrical pin body secured on the distal end of the mixing chamber extends axially from the area of the front wall of the spray head into the mixing chamber. The cylindrical pin body has sections having different diameters, wherein, on the outer circumference of the respective section, axial grooves are formed. In the front wall of the spray head, which axially delimits the mixing chamber, a spray nozzle as well as grooves extending radially towards the spray nozzle are formed centrally.

The aim of the invention is to provide a spray device, in particular for an endoscope, for the application of a substance mixed from at least two components, by means of which the components are mixed in the area of the spray head, and the mixture can be sprayed satisfactorily even at low feed pressure.

Based on a spray device for the application of a substance mixed from at least two components, which comprises a feed device delivering the components of the substance separately from one another, an optionally flexible pipe part which contains in each case a channel for each component of the substance and which is connected by the proximal ends of the channels thereof to the feed device, and a spray head arranged on the distal end of the pipe part and forming a mixing chamber on the distal end of the channels, the spray nozzle of which leads, at a distance from the distal end of the channels, into the mixing chamber, this aim is achieved in that the pipe part has an elongate shape, in particular for use in an endoscope or

the like, and the mixing chamber has a circular cross section which, between the distal ends of the channels and the spray nozzle, comprises a grooved body, in particular a grooved body which can rotate around the circular cross-section axis. This grooved body subdivides the mixing chamber into two chamber sections and has, at on the outer circumference thereof, several spiral twisting grooves connecting the two chamber sections.

In the context of the invention, the two components to be mixed are introduced through separate channels extending next to one another in an elongate pipe part into the spray head. The channels lead into a first chamber section of a mixing chamber subdivided by a grooved body into two chamber sections. In this first chamber section, a first premixing of the components can occur. Subsequently, through spiral twisting grooves formed in the grooved body, the content of the first chamber section reaches the second chamber section. Here, the grooved body can be set in rotation due to the twisting groove configuration, whereby a thorough mixing of the components in the second chamber section is additionally promoted, and the turbulence of the mixed substance is brought about even at low feed pressure when the substance comes out of the spray nozzle.

Such spray devices are used, for example, in the case of an injury, for spraying the thorax with a two-component substance based on fibrin. The two-component substance can here be a two-component adhesive which has a long shelf life and which cures only when it comes in contact with air or physiological fluid.

Furthermore, it should be noted that such spray devices are used, for example, in bronchoscopy, laparoscopy, rectoscopy, also in connection with trocars, and, in particular, in the case of a the scope applications through natural body orifices.

In a preferred embodiment, the mixing chamber and the grooved body can be of substantially cylindrical shape. The grooved body thus formed can move freely within the mixing chamber in axial direction, wherein the longitudinal axes of grooved body and mixing chamber still remain oriented parallel to one another. An additional advantage of the cylindrical configuration consists of the producibility of the grooved body and the mixing chamber. The mixing chamber can be produced simply by drilling of the spray head. The grooved body can be cut to length from bar stock of circular cross section, wherein the twisting grooves can already be formed beforehand in the bar stock.

Moreover, it is proposed that the spray nozzle is arranged centrally with respect to the circular cross-section axis of the mixing chamber in a front wall of the spray head and forms an annular cutting edge which broadens conically towards the mixing chamber and/or towards the outside of the front wall. Since the outlets of the twisting grooves are all at the same distance from the spray nozzle, a consistent draining of the twisting grooves can occur, so that the proportion of the respective components in the mixed substance to be sprayed remains constant during the spraying. The annular cutting edge which broadens conically towards the mixing chamber has the effect that the flow speed and the static pressure of the mixed substance increase towards the spray nozzle. Due to the conical broadening of the annular cutting edge towards the outside of the front wall, turbulence of the mixed substance occurs after it comes out of the spray nozzle.

The turbulence of the substance coming out of the spray nozzle and also the mixing of the components within the mixing chamber can be improved additionally in that the spray nozzle is arranged centrally with respect to the circular cross-section axis of the mixing chamber in a front wall of the spray head, which delimits the mixing chamber, and in that the front wall is approximately conical substantially over entire width thereof towards the mixing chamber.

Since the quantitative ratio of the components in the mixed substance at the outlet of the spray nozzle should correspond to the ratio established in the feed device, it is proposed that the number of the twisting grooves of the grooved body is a whole number, in particular an even multiple of the number of the channels. In particular, the distal ends of the channels and the twisting grooves of the grooved body can be arranged distributed rotationally symmetrically with respect to the circular cross-section axis. Thereby, an even distribution of the components coming out of the channels onto the twisting grooves occurs, since the same number of twisting grooves is associated with the two channels, wherein the distance from the two channels to the associated twisting grooves is also the same. An even draining of the channels and transfer of the components into the second chamber section occur, whereby the proportion of the components in the mixed substance is not subject to variations.

The channels contained in the pipe part can be formed as pipes or tubes. They can be accommodated in a flexible pipe part, for example, in a spiral twisted tube made of metal or in a plastic tube, or in a stiffly resilient metal pipe. However, the channels can also be formed integrally in an extruded pipe part made of plastic. Furthermore, the pipe part can also be produced from a material which makes it possible to permanently bend the pipe part to the desired shape in accordance with the respective utilization requirements.

Preferably, on the proximal end of the pipe part, several connecting elements for the feed device can be held, each connecting element of which is connected respectively to one of the channels, and at least one of the connecting elements, preferably each connecting element, is held on the free end of a stiffly resilient pipe section adjoining the proximal end of the associated channel and protruding substantially freely.

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In order to simplify the plugging of the connecting elements onto the feed device, for example in the form of a dual syringe, the connecting element held on the stiffly resilient pipe section can be slidably guided by means of a plugging guide relative to at least another of the connecting elements and transversely to the pipe part axis. In this way, tolerances at the connections of the dual syringe can be compensated, as a result of which a time consuming and difficult plugging-on is dispensed with.

To make it easy, if necessary, to replace the spray head or to just take it off for cleaning, the spray head can be provided with an inner thread by means of which it can be screwed onto an outer thread of the distal end of the pipe part.

To prevent the grooved body in the mixing chamber from falling out when the spray head is removed from the pipe part, it is proposed that the grooved body is fastened axially, optionally with play, on the spray head by means of loss prevention means. For this purpose, different embodiment possibilities are conceivable.

Below, an embodiment example of the invention is explained in further detail in reference to drawings. In the drawings:

Figure 1 shows a diagrammatic representation of a spray device suitable for applying two-component substances;

Figure 2 shows a cross-sectional view through the distal end of the spray device, and

Figure 3 shows a cross section through the spray head of the spray device, viewed along a line III-III of Figure 2.

The spray device 10 represented in Figure 1 makes it possible, via an instrument channel of an endoscope, not shown in further detail, or the like, to spray a substance mixed from two components during passage through an elongate pipe part. The two components to be mixed are here first mixed with one another within a spray head immediately before the spraying. Endoscopes on which the spray device can be used are known and will not to be explained further. The substance to be sprayed is, for example, a two-component tissue adhesive based on fibrin, which is used for application in the case of injuries to the thorax.

The spray device 10 here comprises a stiff pipe part 12, within which two channels which are formed as pipes 14, 16 extend, as can be seen better in Figure 2. On proximal ends of the pipes 14, 16, stiffly resilient pipe sections 14a, 16a protrude freely. On the free ends of the pipe sections 14a, 16a, connecting elements 24, 26 are held, via which a feed device 22 is connected. The pipe sections 14a, 16a are fixed in the pipe part 12, for example, by soldering. Furthermore, on the distal end of the pipe part 12, a spray head 28 is attached.

Here, for example, the connecting elements 24, 26 are luerlock connectors, to which the feed device 22 for the components of the substance to be sprayed, for example, a dual syringe or the like, can be detachably connected.

The fluid components contained in the dual syringe 22 are fed, via the pipe sections 14a, 16a and the pipes 14, 16, are to the spray head 28 into which the pipes 14, 16 lead. The components are mixed in the spray head 28 and sprayed as a mixture which is cured subsequently through a spray nozzle 30 formed in the spray head 28.

Figure 2 shows details of the spray head 28. Within the spray head 28, a substantially cylindrical mixing chamber 32 is secured. The spray nozzle 30 is formed centrally in a front wall 34 of the spray head 28. With its end axially opposite the front wall 34, the spray head 28 is screwed via an inner thread 36 onto an outer thread 38 on the distal end of the pipe part 12.

On the distal end, the pipe part 12 has a cross section which is enlarged with respect to the rest of its length, with a circumferential ledge 40 directly adjoining the outer thread 38. On this ledge 40, a sealing ring 42 is placed in order to seal the mixing chamber 32 from the outside. By means of the ledge 40 functioning as an abutment when the spray head 28 is screwed onto the distal end of the pipe part 12, a defined axial distance between the distal end of the pipe part 12 and the spray nozzle 30 and thereby the axial length of the mixing chamber 32 are established.

As can also be seen from Figure 2, the spray nozzle 30 is formed by an annular cutting edge 44 which broadens conically towards the outside of the front wall 34 of the spray head 28. From the annular cutting edge 44 on, the front wall 34 is broadened conically over the entire width thereof towards the mixing chamber 32.

The mixing chamber 32 accommodates a cylindrical grooved body 46 which subdivides the mixing chamber 32 into two chamber sections 32a and 32b. On the outer circumference of the grooved body 46, spiral twisting grooves 48 are formed, which are distributed rotationally symmetrically with respect to a circular cross-section axis A. The twisting grooves 48 connect the two chamber sections 32a and 32b to one another.

Via the pipes 14, 16, the two components of the substance to be sprayed now reach the chamber section 32a, where a first premixing takes place. Subsequently, the partially premixed two-component substance, by means of the twisting grooves 48, reaches

the chamber section 32b. In this connection, it should be mentioned that the number of the twisting grooves 48 should correspond to a whole-number multiple of the pipes 14, 16 leading into the chamber section 38a. In the present case, four twisting grooves are formed on the outer circumference of the grooved body 46, as can be seen in Figure 3. In this manner, the components coming out of the pipes 14, 16 are quantitatively distributed evenly over the twisting grooves 48.

The mixing in the second chamber section 32b is brought about by the radial and the circumferential component of the components coming out of the twisting grooves 48. If the grooved body 46 can rotate around the circular cross-section axis A, the rotation component of the grooved body 46 can additionally promote the mixing of the components.

As a result of the narrowing mixing chamber cross section, the through-flow speed or outlet speed and the static pressure of the substance to be sprayed are increased. The annular cutting edge 44 broadening conically towards the outside brings about turbulence or misting of the substance and thus the spraying effect.

As can be seen from Figure 1, adjoining the connecting elements 24, 26 held on the end of the stiffly resilient pipe sections 14a, 16a, a plugging guide 50 is attached, which slidably guides the connecting elements 24, 26 transversely to the longitudinal axis of the pipe part 12, so that the distance between the connecting elements 24, 26 can be varied within a certain range. This has the advantage that, when the connecting elements 24, 26 are plugged onto the dual syringe 22, tolerances of the dual syringe 22 can be compensated and thus an easy plugging of the connecting elements 24, 26 onto the dual syringe 22 is possible.

On the distal end of the pipe part 12, a cap 52 is inserted. This cap is used to

prevent the fluid components, after they have come out of the pipes 14, 16, from entering the inner space of the pipe part 12 which is not occupied by the pipes 14, 16. On the other hand, the pipes 14, 16 are plugged into recesses 54, 56 of the cap 52. The recesses 54, 56 are arranged rotationally symmetrically with respect to the circular cross-section axis, so that, in this way, the pipes 14, 16 are also held rotationally symmetrically with respect to the circular cross-section axis.

In the area of the first chamber section 32a, an annular element 58 is welded on the inner wall of the spray head 28, which delimits the mixing chamber 32. This annular element 58 is welded, after the insertion of the grooved body 46, into the mixing chamber 32, in order to prevent the grooved body 46 from falling out. However, other loss prevention possibilities are also conceivable.

The channels or pipes 14, 16 can also be designed as flexible tube parts which are accommodated in a flexible guide tube. Moreover, the pipe part can also be produced by extrusion, wherein the channels 14, 16 are then formed integrally. The pipe part 12 can be manufactured, for example, from a metal or plastic. Furthermore, embodiments are also conceivable, in which the pipe part 12 can in each case be bent permanently to the shape necessary for the specific use.

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Claims

1. A spray device for application of a substance mixed from at least two components, comprising:

   a feed device (22) delivering the components of the substance separately from one another,

   an optionally flexible pipe part (12) which contains in each case a channel (14, 16) for each component of the substance and which is to be connected by the proximal ends of the channels (14, 16) thereof to the feed device (22), and

   a spray head (28) arranged on the distal end of the pipe part (12) and forming a mixing chamber (32) on the distal end of the channels (14, 16), the spray nozzle (30) of which leads, at a distance from the distal ends of the channels (14, 16), into the mixing chamber (32),

   characterized in that

   the pipe part (12) has an elongate shape, in particular for use in an endoscope or the like, and that the mixing chamber (32) has a circular cross section and comprises, between the distal ends of the channels (14, 16) and the spray nozzle (30), a grooved body (46), in particular a grooved body (46) which can rotate around the circular cross-section axis (A) which subdivides the mixing chamber (32) into two chamber sections (32a, 32b) and which has, on the outer circumference thereof, several spiral twisting grooves (48) connecting the two chamber sections (32a, 32b).

2. The spray device according to Claim 1, characterized in that the mixing chamber (32) and the grooved body (46) in each case have a substantially cylindrical shape.

3. The spray device according to Claim 1 or 2, characterized in that the spray nozzle (30) is arranged centrally with respect to the circular cross-section axis (A) of the mixing chamber (32) in a front wall (34) of the spray head (28) and forms an annular cutting edge (44) which broadens conically towards the mixing chamber (32) and/or towards the outside of the front wall (34) thereof.

4. The spray device according to any one of Claims 1 to 3, characterized in that the spray nozzle (30) is arranged centrally with respect to the circular cross-section axis (A) of the mixing chamber (32) in a front wall (34) of the spray head, which delimits the mixing chamber (32), and that the front wall (34) is approximately conical substantially over the entire width thereof towards the mixing chamber (32).

5. The spray device according to any one of Claims 1 to 4, characterized in that the number of the twisting grooves (48) of the grooved body (46) is a whole number, in particular an even multiple of the number of the channels (14, 16).

6. The spray device according to any one of Claims 1 to 5, characterized in that the distal ends of the channels (14, 16) and the twisting grooves (48) of the grooved body (46) are arranged distributed rotationally symmetrically with respect to the circular cross-section axis (A).

7. The spray device according to any one of Claims 1 to 6, characterized in that the channels (14, 16) contained in the pipe part (12) are formed as pipes or tubes.

8. The spray device according to any one of Claims 1 to 7, characterized in that, on the proximal end of the pipe part (12), several connecting elements (24, 26) for

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the feed device (22) are held, each connecting element (24, 26) of which is connected in each case to one of the channels (14, 16), and at least one of the connecting elements (24, 26), preferably each of the connecting elements (24, 26), is held on the free end of a stiffly resilient pipe section adjoining the proximal end of the associated channel (14, 16) and protruding substantially freely.

9. The spray device according to Claim 8, characterized in that the connecting element (24, 26) held on the stiffly resilient pipe section is slidably guided by means of a guide (50) relative to at least another of the connecting elements (24, 26) and transversely to the pipe part axis.

10. . The spray device according to any one of the preceding claims, characterized in that the spray head (28) is provided with an inner thread (36) by means of which it is screwed onto an outer thread (38) of the distal end of the pipe part (12).

11. The spray device according to any one of the preceding claims, characterized in that the grooved body (46) is fastened optionally with play on the spray head (28) by loss prevention means (58).

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Oct. 10, 1995

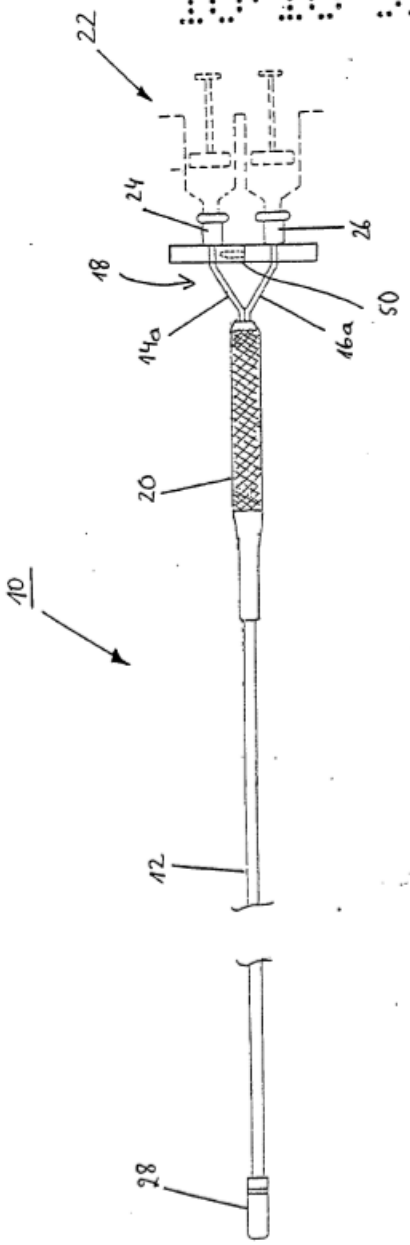

Fig. 1

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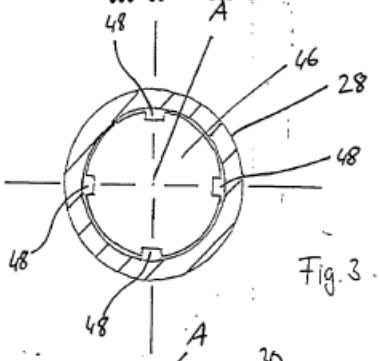

Fig. 3

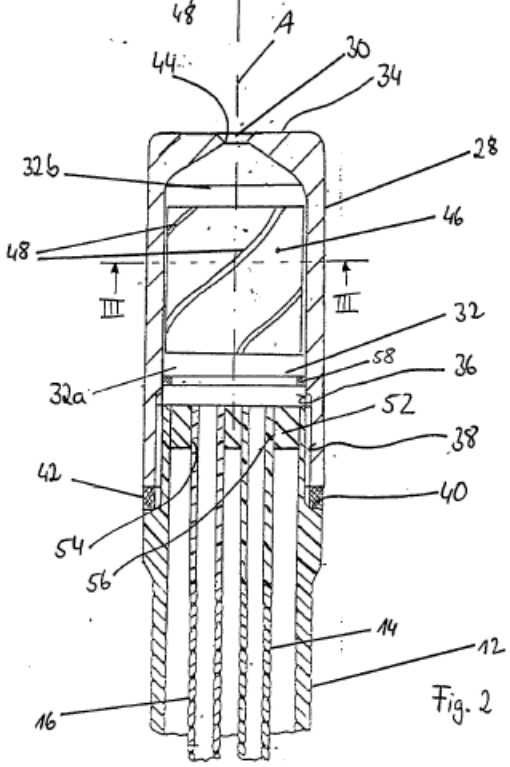

Fig. 2

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Certification

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TRANSLATOR'S DECLARATION:

I, Francois Lux, hereby declare:

That I possess advanced knowledge of the German and English languages. The attached German into English translation has been translated by me and to the best of my knowledge and belief, it is a true and accurate translation of: DE29516077U1

I hereby acknowledge that any willful false statement and the like made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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Sprühvorrichtung

Die Erfindung betrifft eine Sprühvorrichtung zur Applikation einer aus wenigstens zwei Komponenten gemischten Substanz.

Aus der deutschen Gebrauchsmusterschrift G 86 23 423 ist eine Injektionseinrichtung für ein Endoskop bekannt, mittels welcher Zwei-Komponenten-Substanzen, insbesondere Zwei-Komponenten-Gewebekleber injiziert werden können. Die Injektionseinrichtung umfaßt einen in den Instrumentenkanal des Endoskops einzuführenden Führungsschlauch, in welchem zwei Schlauchleitungen für die Zuführung von Flüssigkeitskomponenten des Zwei-Komponenten-Gewebeklebers verschiebbar geführt sind. Am distalen Ende der Schlauchleitungen ist ein aus zwei Kopfteilen bestehender Mischkopf angebracht. Der Mischkopf enthält eine Mischkammer, die durch ein Sackloch in einem der Kopfteile und durch einen Ansatz des anderen Kopfteils begrenzt wird. Die Schlauchleitungen münden lediglich teilweise überlappend mit der Mischkammer, so daß die Flüssigkeitskomponenten mit radialer Komponente in die Mischkammer einströmen. Das den Ansatz tragende Kopfteil ist mit einer Injektionskanüle fest verbunden und mit dem anderen Kopfteil verschraubt.

Weiterhin ist eine Sprühkanüle bekannt. Die Sprühkanüle umfaßt ein mit seinen proximalen Anschlußteilen auf eine Zufuhreinrichtung aufsteckbares Zwischenelement, sowie einen an

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diesem anbringbaren Sprühkopf. In dem Zwischenelement sind Kanäle für die von der Zufuhreinrichtung kommenden zu vermischenden Komponenten ausgebildet. Die Kanäle in dem Zwischenelement verlaufen zunächst von einem an die Zufuhreinrichtung anschließenden Abschnitt des Zwischenelementes aufeinander zu, danach in einem dem Sprühkopf nahen Abschnitt parallel. In dem distalen Abschnitt des Zwischenelements münden sie in eine durch den Sprühkopf festgelegte Mischkammer aus. Ein am distalen Ende der Mischkammer festgelegter zylindrischer Stiftkörper erstreckt sich axial vom Bereich der Stirnwand des Sprühkopfes in die Mischkammer. Der zylindrische Stiftkörper weist Abschnitte mit unterschiedlichen Durchmessern auf, wobei am Außenumfang des jeweiligen Abschnittes Axialnuten ausgebildet sind. In der die Mischkammer axial begrenzenden Stirnwand des Sprühkopfes sind eine Sprühdüse sowie radial zur Sprühdüse hin verlaufende Nuten zentrisch ausgebildet.

Es ist Aufgabe der Erfindung, eine Sprühvorrichtung, insbesondere für ein Endoskop, zur Applikation einer aus wenigstens zwei Komponenten gemischten Substanz bereitzustellen, mittels welcher die Komponenten im Bereich des Sprühkopfes gemischt werden und die Mischung auch bei niedrigem Zufuhrdruck gut versprüht werden kann.

Ausgehend von einer Sprühvorrichtung zur Applikation einer aus wenigstens zwei Komponenten gemischten Substanz, die eine die Komponenten der Substanz gesondert voneinander abgebende Zufuhreinrichtung, ein je einen Kanal für jede Komponente der Substanz enthaltenes und mit den proximalen Enden seiner Kanäle mit Zufuhreinrichtung verbundenes, gegebenenfalls flexibles Rohrteil und einen am distalen Ende des Rohrteils angeordneten, eine Mischkammer am distalen Ende der Kanäle bildenden Sprühkopf, dessen Sprühdüse im Abstand zu den distalen Enden der Kanäle in der Mischkammer mündet, umfaßt, wird diese Aufgabe dadurch gelöst, daß das Rohrteil langgestreckte Form, insbesondere für die Verwendung in einem Endoskop oder

dergleichen hat und die Mischkammer einen Kreisquerschnitt aufweist, welcher zwischen den distalen Enden der Kanäle und der Sprühdüse einen Nutköper, insbesondere einen um die Kreisquerschnittsachse drehbaren Nutkörper enthält. Dieser Nutkörper unterteilt die Mischkammer in zwei Kammerabschnitte und weist an seinem Außenumfang mehrere, die beiden Kammerabschnitte verbindende, wendelförmige Drallnuten auf.

Im Rahmen der Erfindung werden die beiden zu vermischenden Komponenten durch getrennte, in einem langgestreckten Rohrteil nebeneinander verlaufende Kanäle in den Sprühkopf eingeführt. Die Kanäle münden in einen ersten Kammerabschnitt einer durch einen Nutkörper in zwei Kammerabschnitte unterteilten Mischkammer. In diesem ersten Kammerabschnitt kann es zu einer ersten Vorvermischung der Komponenten kommen. Der Inhalt des ersten Kammerabschnitts gelangt anschließend durch in dem Nutkörper ausgebildete, wendelförmige Drallnuten in den zweiten Kammerabschnitt. Hierbei kann der Nutkörper aufgrund der Drallnuten-Ausbildung in Rotation versetzt werden, wodurch eine innige Durchmischung der Komponenten im zweiten Kammerabschnitt zusätzlich begünstigt wird und die Verwirbelung der gemischten Substanz auch bei niedrigem Zufuhrdruck bei Austritt aus der Sprühdüse bewirkt wird.

Solche Sprühvorrichtungen werden beispielsweise verwendet, um die Thorax bei einer Verletzung mit einer Zwei-Komponenten-Substanz auf Fibrinbasis zu besprühen. Bei der Zwei-Komponenten-Substanz kann es sich dabei um einen solchen Zwei-Komponenten-Kleber, der eine lange Standzeit aufweist und der erst dann aushärtet, wenn er mit Luft oder Körperflüssigkeit in Kontakt gelangt.

Ferner sei angemerkt, daß derartige Sprühvorrichtungen beispielsweise bei der Bronchoskopie, der Laparoskopie, der Rektoskopie, auch in Verbindung mit Trokaren und insbesondere bei Skopanwendungen durch natürliche Körperöffnungen zur Anwendung kommen.

In einer bevorzugten Ausführungsform können die Mischkammer und der Nutkörper im wesentlichen Zylinderform haben. Der so geformte Nutkörper kann sich innerhalb der Mischkammer in Axialrichtung frei bewegen, wobei die Längsachsen von Nutkörper und Mischkammer weiterhin zueinander parallel ausgerichtet bleiben. Ein weiterer Vorteil der zylinderförmigen Ausbildung liegt in der Herstellbarkeit des Nutkörpers und der Mischkammer. Die Mischkammer läßt sich einfach durch Bohren des Sprühkopfes herstellen. Der Nutkörper kann von einem Stangenmaterial mit Kreisquerschnitt abgelängt werden, wobei die Drallnuten bereits vorher in dem Stangenmaterial ausgebildet werden können.

Es wird weiter vorgeschlagen, daß die Sprühdüse zur Kreisquerschnittsachse der Mischkammer zentrisch in einer Stirnwand des Sprühkopfes angeordnet ist und eine Ringschneide bildet, die sich zur Mischkammer oder/und zur Außenseite der Stirnwand konisch erweitert. Da die Ausgänge der Drallnuten alle den gleichen Abstand zur Sprühdüse haben, kann eine gleichmäßige Entleerung der Drallnuten stattfinden, so daß der Anteil der jeweiligen Komponenten in der zu versprühenden, gemischten Substanz im Verlauf des Versprühens konstant bleibt. Die sich zur Mischkammer hin konisch erweiternde Ringschneide bewirkt, daß sich die Strömungsgeschwindigkeit und der statische Druck der gemischten Substanz zur Sprühdüse hin erhöhen. Aufgrund der konischen Erweiterung der Ringschneide zur Außenseite der Stirnwand erfolgt eine Verwirbelung der gemischten Substanz nach Austritt aus der Sprühdüse.

Die Verwirbelung der aus der Sprühdüse austretenden Substanz und auch die Vermischung der Komponenten innerhalb der Mischkammer können zusätzlich dadurch verbessert werden, daß die Sprühdüse zu Kreisquerschnittsachse der Mischkammer zentrisch in eine die Mischkammer begrenzenden Stirnwand ihres Sprühkopfes angeordnet ist und daß die Stirnwand zur Mischkammer hin im wesentlichen über ihre gesamte Breite annähernd konusförmig ist.

Da das Mengenverhältnis der Komponenten in der gemischten Substanz am Ausgang der Sprühdüse dem in der Zufuhreinrichtung festgelegten Verhältnis entsprechen soll, wird vorgeschlagen, daß die Anzahl der Drallnuten des Nutkörpers ein ganzzahliges, insbesondere ein geradzahliges Vielfaches der Anzahl der Kanäle ist. Insbesondere können die distalen Enden der Kanäle und die Drallnuten des Nutkörpers zur Kreisquerschnittsachse rotationssymmetrisch verteilt angeordnet sein. Hierdurch erfolgt eine gleichmäßige Verteilung der aus den Kanälen austretenden Komponenten auf die Drallnuten, da beiden Kanälen eine gleiche Anzahl von Drallnuten zugeordnet ist, wobei auch der Weg zu den zugeordneten Drallnuten von beiden Kanälen aus der gleiche ist. Es erfolgt eine gleichmäßige Entleerung der Kanäle und Weiterleitung der Komponenten in den zweiten Kammerabschnitt, wodurch der Anteil der Komponenten in der gemischten Substanz keinen Schwankungen unterliegt.

Die in dem Rohrteil enthaltenen Kanäle können als Rohre oder Schläuche ausgebildet sein. Diese können entweder in einem flexiblen Rohrteil, beispielsweise einem wendelförmig gedrehten Schlauch aus Metall oder einem Kunststoffschlauch, oder einem steifelastischem Metallrohr aufgenommen sein. Die Kanäle können jedoch auch integral in einem extrudierten Rohrteil aus Kunststoff ausgebildet sein. Ferner kann das Rohrteil auch aus einem Material hergestellt sein, das es erlaubt, das Rohrteil den jeweiligen Einsatzanforderungen entsprechend bleibend in die benötigte Form zu biegen.

Bevorzugt können am proximalen Ende des Rohrteils mehrere Anschlußelemente für die Zufuhreinrichtung gehalten sein, von denen jedes Anschlußelement mit je einem der Kanäle verbunden ist und zumindest eines der Anschlußelemente, vorzugsweise jedes Anschlußelement, am freien Ende eines an das proximale Ende des zugeordneten Kanals anschließenden, im wesentlichen frei abstehenden, steifelastischen Rohrstücks gehalten ist.

Um das Aufstecken der Anschlußelemente auf die Zufuhreinrichtung, beispielsweise in Form einer Doppelspritze, zu vereinfachen, kann das an dem steifelastischen Rohrstück gehaltene Anschlußelement mittels einer Steckführung relativ zu wenigstens einem anderen der Anschlußelemente und quer zur Rohrteilachse verschiebbar geführt sein. Toleranzen an den Anschlüssen der Doppelspritze können auf diese Weise ausgeglichen werden, wodurch ein zeitaufwendiges und mühsames Aufstecken entfällt.

Damit bei Bedarf der Sprühkopf leicht ausgetauscht werden oder lediglich zur Reinigung abgenommen werden kann, kann der Sprühkopf mit einem Innengewinde versehen sein, mit welchem er auf ein Außengewinde des distalen Endes des Rohrteils aufgeschraubt ist.

Damit der Nutkörper in der Mischkammer bei Abnahme des Sprühkopfes von dem Rohrteil nicht herausfällt, wird vorgeschlagen, daß der Nutkörper an dem Sprühkopf durch Verlustsicherungsmittel axial, gegebenenfalls mit Spiel fixiert ist. Hierzu sind unterschiedliche Ausführungsmöglichkeiten denkbar.

Im folgenden wird ein Ausführungsbeispiel der Erfindung anhand von Zeichnungen näher erläutert. Es zeigt:

Figur 1 eine schematische Darstellung einer zur Applikation von Zwei-Komponenten-Substanzen geeigneten Sprühvorrichtung;

Figur 2 eine Schnittansicht durch das distale Ende der Sprühvorrichtung und

Figur 3 einen Querschnitt durch den Sprühkopf der Sprühvorrichtung, gesehen entlang einer Linie III-III der Figur 2.

Die in Figur 1 dargestellte Sprühvorrichtung 10 erlaubt es, über einen Instrumentenkanal eines nicht näher dargestellten Endoskops oder dergleichen eine aus zwei Komponenten gemischte Substanz bei Durchführung durch ein langgestrecktes Rohrteil bei niedrigem Zufuhrdruck zu versprühen. Die beiden zu vermischenden Komponenten werden dabei erst unmittelbar vor dem Versprühen innerhalb eines Sprühkopfes miteinander vermischt. Endoskope, an welchen die Sprühvorrichtung verwendet werden kann, sind bekannt und sollen nicht weiter erläutert werden. Bei der zu versprühenden Substanz handelt es sich beispielsweise um einen Zwei-Komponenten-Gewebekleber auf Fibrinbasis, der zur Applikation bei Verletzungen der Thorax verwendet wird.

Die Sprühvorrichtung 10 umfaßt hier ein steifes Rohrteil 12, innerhalb welchem zwei Kanäle, die als Rohre 14, 16 ausgebildet sind, wie in Figur 2 besser zu sehen, verlaufen. An proximalen Enden der Rohre 14, 16 stehen steifelastische Rohrstücke 14a, 16a frei ab. An den freien Enden der Rohrstücke 14a, 16a sind Anschlußelemente 24, 26 gehalten über die eine Zufuhreinrichtung 22 angeschlossen ist. Die Rohrstücke 14a, 16a sind in dem Rohrteil 12 fixiert, beispielsweise eingelötet. Ferner ist am distalen Ende des Rohrteils 12 ein Sprühkopf 28 angebracht.

Die Anschlußelemente 24, 26 sind hier beispielsweise Luer-Lock-Anschlüsse, an die die Zufuhreinrichtung 22 für die Komponenten der zu versprühenden Substanz, beispielsweise eine Doppelspritze oder dergleichen, lösbar angeschlossen werden kann.

Die in der Doppelspritze 22 enthaltenen Flüssigkeitskomponenten werden über die Rohrstücke 14a, 16a und die Rohre 14, 16 dem Sprühkopf 28, in welchen die Rohre 14, 16 ausmünden, zugeführt. Die Komponenten vermischen sich in dem Sprühkopf 28 und werden als nachfolgend aushärtende Mischung durch eine im Sprühkopf 28 ausgebildete Sprühdüse 30 versprüht.

Figur 2 zeigt Einzelheiten des Sprühkopfes 28. Innerhalb des Sprühkopfes 28 ist eine im wesentlichen zylinderförmige Mischkammer 32 festgelegt. Die Sprühdüse 30 ist zentrisch in einer Stirnwand 34 des Sprühkopfes 28 ausgebildet. Mit seinem der Stirnwand 34 axial entgegengesetzten Ende ist der Sprühkopf 28 über ein Innengewinde 36 auf ein Außengewinde 38 am distalen Ende des Rohrteils 12 aufgeschraubt.

Das Rohrteil 12 weist an dem distalen Ende einen in Bezug auf seine übrige Länge vergrößerten Querschnitt mit einem umlaufenden Absatz 40 unmittelbar an das Außengewinde 38 anschließend auf. Auf diesen Absatz 40 ist ein Dichtring 42 aufgesetzt, um die Mischkammer 32 nach außen abzudichten. Durch den beim Aufschrauben des Sprühkopfes 28 auf das distale Ende des Rohrteils 12 als Anschlag fungierenden Absatz 40 wird ein definierter axialer Abstand zwischen dem distalen Ende des Rohrteils 12 und der Sprühdüse 30 und somit die axiale Länge der Mischkammer 32 festgelegt.

Wie weiter aus Figur 2 zu ersehen, ist die Sprühdüse 30 von einer Ringschneide 44 gebildet, welche sich zur Außenseite der Stirnwand 34 des Sprühkopfes 28 konusförmig erweitert. Von der Ringschneide 44 aus ist die Stirnwand 34 über ihre gesamte Breite zur Mischkammer 32 hin konusförmig erweitert.

Die Mischkammer 32 nimmt einen zylinderförmigen Nutkörper 46 auf, der die Mischkammer 32 in zwei Kammerabschnitte 32a und 32b unterteilt. Am Außenumfang des Nutkörpers 46 sind wendelförmige Drallnuten 48 ausgebildet, welche zu einer Kreisquerschnittsache A rotationssymmetrisch verteilt sind. Die Drallnuten 48 verbinden die beiden Kammerabschnitte 32a und 32b miteinander.

Die zwei Komponenten der zu versprühenden Substanz gelangen nun über die Rohre 14, 16 in den Kammerabschnitt 32a, wo eine erste Vorvermischung stattfindet. Anschließend gelangt die teilweise vorvermischte Zwei-Komponenten-Substanz durch die Drallnuten 48

in den Kammerabschnitt 32b. In diesem Zusammenhang sei erwähnt, daß die Anzahl der Drallnuten 48 einem ganzzahligen Vielfachen der in den Kammerabschnitt 38a mündenden Rohre 14, 16 entsprechen sollte. Im vorliegenden Fall sind vier Drallnuten, wie in Figur 3 zu erkennen ist, am Außenumfang des Nutkörpers 46 ausgebildet. Auf diese Weise werden die aus den Rohren 14, 16 austretenden Komponenten quantitativ gleichmäßig auf die Drallnuten 48 verteilt.

Die Vermischung in dem zweiten Kammerabschnitt 32b wird durch die Radial- und die Umfangskomponente der aus den Drallnuten 48 austretenden Komponenten bewirkt. Wenn sich der Nutkörper 46 um die Kreisquerschnittsachse A drehen kann, kann die Rotationskomponente des Nutkörpers 46 die Vermischung der Komponenten zusätzlich begünstigen.

Durch den sich verengenden Mischkammerquerschnitt erhöht sich die Durchfluß- bzw. Austrittsgeschwindigkeit und der statische Druck der zu versprühenden Substanz. Die zur Außenseite hin sich konisch erweiternde Ringschneide 44 bewirkt eine Verwirbelung bzw. Vernebelung der Substanz und damit die Sprühwirkung.

Wie aus Figur 1 zu ersehen ist, ist angrenzend an die am Ende der steifelastischen Rohrstücke 14a, 16a gehaltenen Anschlußelemente 24, 26 eine Steckführung 50 angebracht, die die Anschlußelemente 24, 26 quer zur Längsachse des Rohrteils 12 verschiebbar führt, so daß der Abstand zwischen den Anschlußelementen 24, 26 in einem gewissen Bereich verändert werden kann. Dies hat den Vorteil, daß bei dem Aufstecken der Anschlußelemente 24, 26 auf die Doppelspritze 22 Toleranzen der Doppelspritze 22 ausgeglichen werden können und somit ein problemloses Aufstecken der Anschlußelemente 24, 26 auf die Doppelspritze 22 möglich ist.

Am distalen Ende des Rohrteils 12 ist eine Kappe 52 eingesetzt. Diese dient zum einen dazu, das Eindringen der

Flüssigkeitskomponenten nach ihrem Austritt aus den Rohren 14, 16 in den von den Rohren 14, 16 nicht ausgefüllten Innenraum des Rohrteils 12 zu verhindern. Zum anderen sind die Rohre 14, 16 in Ausnehmungen 54, 56 der Kappe 52 eingesteckt. Die Ausnehmungen 54, 56 sind rotationssymmetrisch zur Kreisquerschnittsachse angeordnet, so daß auf diese Weise auch die Rohre 14, 16 rotationssymmetrisch zur Kreisquerschnittsachse gehalten sind.

Im Bereich des ersten Kammerabschnittes 32a ist an der die Mischkammer 32 begrenzenden Innenwand des Sprühkopfes 28 ein Ringelement 58 angeschweißt. Dieses Ringelement 58 wird nach dem Einstecken des Nutkörpers 46 in die Mischkammer 32 eingeschweißt, um den Nutkörper 46 gegen Herausfallen zu sichern. Es sind jedoch auch andere Möglichkeiten der Verlustsicherung denkbar.

Die Kanäle bzw. Rohre 14, 16 können auch als flexible Schlauchteile ausgebildet sein, die in einem flexiblen Führungsschlauch aufgenommen sind. Desweiteren läßt sich das Rohrteil auch durch Extrudieren herstellen, wobei dann die Kanäle 14, 16 integral ausgebildet sind. Das Rohrteil 12 kann beispielsweise aus einem Metall oder Kunststoff gefertigt sein. Ferner sind auch Ausführungsformen denkbar, bei denen das Rohrteil 12 jeweils in die für den speziellen Einsatz benötigte Form bleibend biegbar ist.

Ansprüche

1. Sprühvorrichtung zur Applikation einer aus wenigstens zwei Komponenten gemischten Substanz, umfassend:
eine die Komponenten der Substanz gesondert voneinander abgebende Zufuhreinrichtung (22),
ein je einen Kanal (14, 16) für jede Komponente der Substanz enthaltenes und mit den proximalen Enden seiner Kanäle (14, 16) mit der Zufuhreinrichtung (22) zu verbindendes, gegebenenfalls flexibles Rohrteil (12) und
einen am distalen Ende des Rohrteils (12) angeordneten, eine Mischkammer (32) am distalen Ende der Kanäle (14, 16) bildenden Sprühkopf (28), dessen Sprühdüse (30) im Abstand zu den distalen Enden der Kanäle (14, 16) in der Mischkammer (32) mündet,
dadurch gekennzeichnet,
daß das Rohrteil (12) langgestreckte Form, insbesondere für die Verwendung in einem Endoskop oder dergleichen hat und daß die Mischkammer (32) Kreisquerschnitt hat und zwischen den distalen Enden der Kanäle (14, 16) und der Sprühdüse (30) einen Nutkörper (46), insbesondere einen um die Kreisquerschnittsachse (A) drehbaren Nutkörper (46) enthält, der die Mischkammer (32) in zwei Kammerabschnitte (32a, 32b) unterteilt und an seinem Außenumfang mehrere, die beiden Kammerabschnitte (32a, 32b) verbindende, wendelförmige Drallnuten (48) aufweist.

2. Sprühvorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Mischkammer (32) und der Nutkörper (46) im wesentlichen Zylinderform haben.

3. Sprühvorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Sprühdüse (30) zur Kreisquerschnittsachse (A) der Mischkammer (32) zentrisch in einer Stirnwand (34) des Sprühkopfes (28) angeordnet ist und eine Ringschneide (44) bildet, die sich zur Mischkammer (32) oder/und zur Außenseite ihrer Stirnwand (34) konisch erweitert.

4. Sprühvorrichtung nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß die Sprühdüse (30) zur Kreisquerschnittsachse (A) der Mischkammer (32) zentrisch in einer die Mischkammer (32) begrenzenden Stirnwand (34) des Sprühkopfes angeordnet ist und daß die Stirnwand (34) zur Mischkammer (32) hin im wesentlichen über ihre gesamte Breite angenähert konusförmig ist.

5. Sprühvorrichtung nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß die Anzahl der Drallnuten (48) des Nutkörpers (46) ein ganzzahliges, insbesondere ein geradzahliges Vielfaches der Anzahl der Kanäle (14, 16) ist.

6. Sprühvorrichtung nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, daß die distalen Enden der Kanäle (14, 16) und die Drallnuten (48) des Nutkörpers (46) zur Kreisquerschnittsachse (A) rotationssymmetrisch verteilt angeordnet sind.

7. Sprühvorrichtung nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß die in dem Rohrteil (12) enthaltenen Kanäle (14, 16) als Rohre oder Schläuche ausgebildet sind.

8. Sprühvorrichtung nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß am proximalen Ende des Rohrteils (12) mehrere Anschlußelemente (24, 26) für

die Zufuhreinrichtung (22) gehalten sind, von denen jedes Anschlußelement (24, 26) mit je einem der Kanäle (14, 16) verbunden ist und zumindest eines der Anschlußelemente (24, 26), vorzugsweise jedes der Anschlußelemente (24, 26), am freien Ende eines an das proximale Ende des zugeordneten Kanals (14, 16) anschließenden, im wesentlichen frei abstehenden, steifelastischen Rohrstücks gehalten ist.

9. Sprühvorrichtung nach Anspruch 8, dadurch gekennzeichnet, daß das an dem steifelastischen Rohrstück gehaltene Anschlußelement (24, 26) mittels einer Führung (50) relativ zu wenigstens einem anderen der Anschlußelemente (24, 26) und quer zur Rohrteilachse verschiebbar geführt ist.

10. Sprühvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Sprühkopf (28) mit einem Innengewinde (36) versehen ist, mit welchem er auf ein Außengewinde (38) des distalen Endes des Rohrteils (12) aufgeschraubt ist.

11. Sprühvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Nutkörper (46) an dem Sprühkopf (28) durch Verlustsicherungsmittel (58), gegebenenfalls mit Spiel fixiert ist.

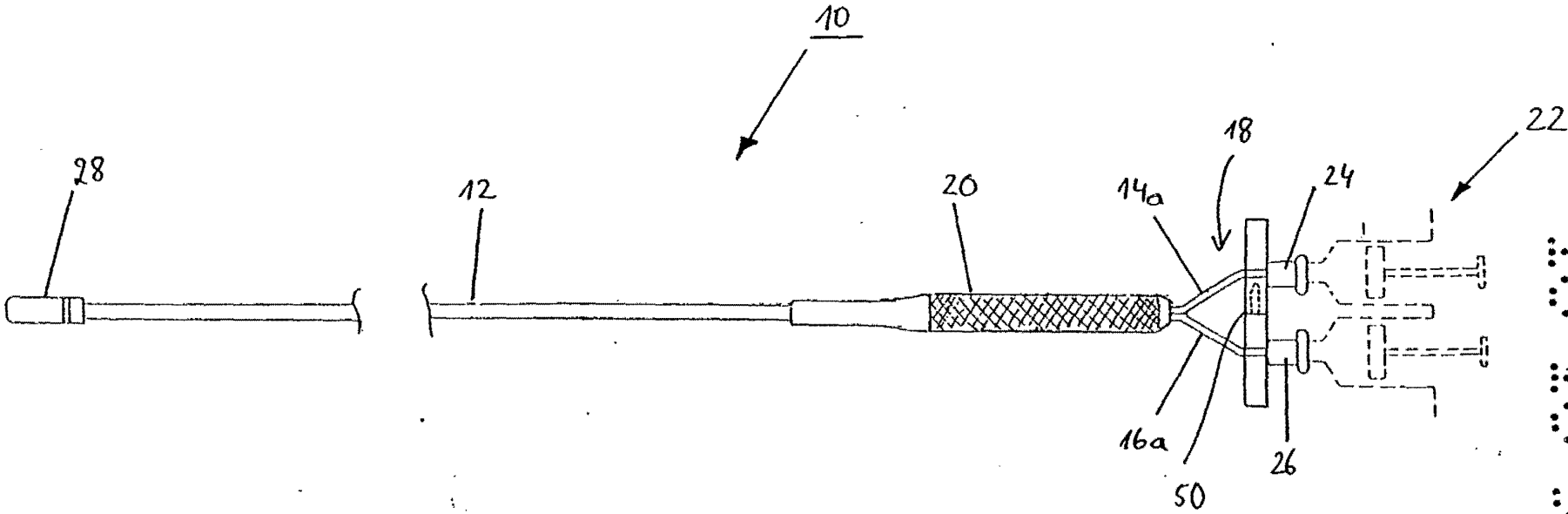

Fig. 1

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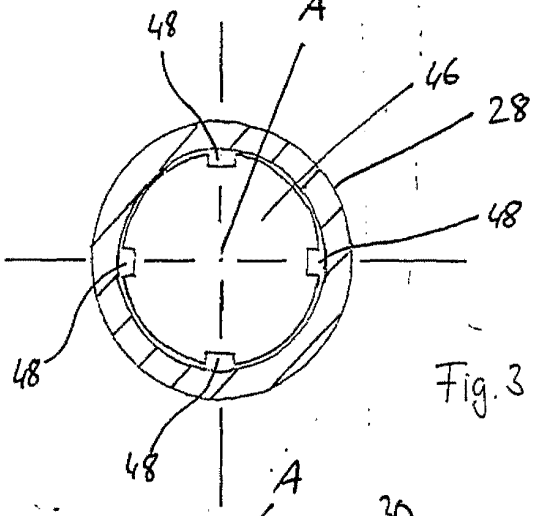

Fig. 3

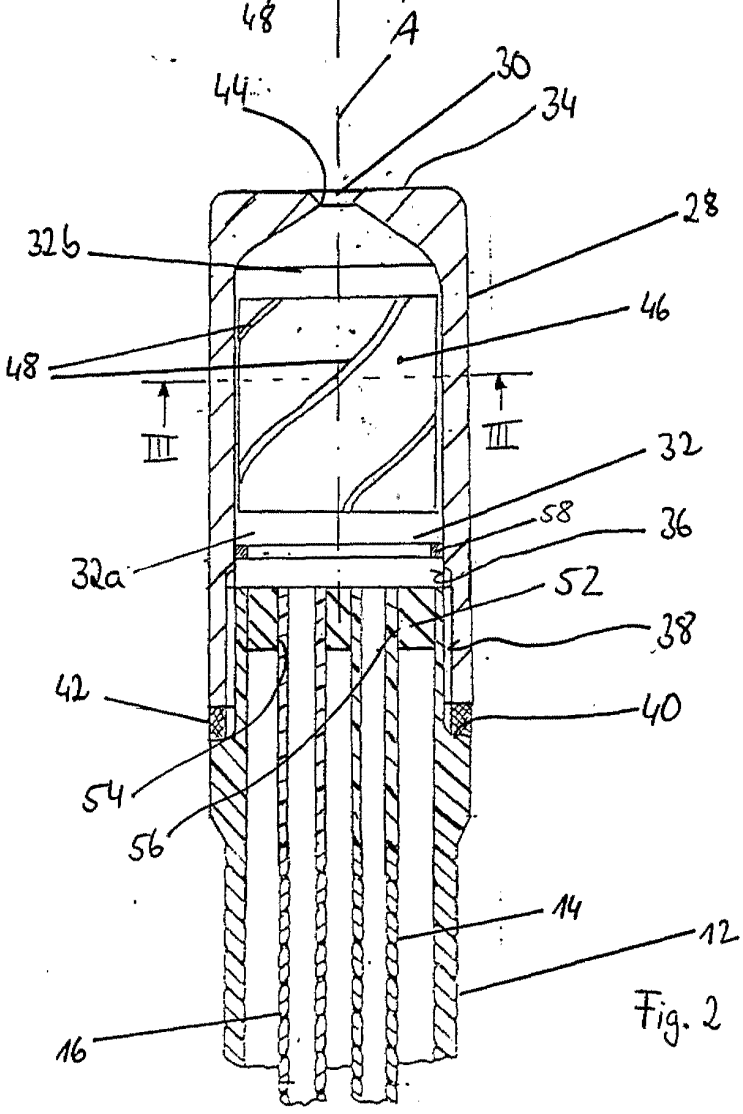

Fig. 2

EXHIBIT 6

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER	
GORMAN, DARREN W	
ART UNIT	PAPER NUMBER
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NOTIFICATION DATE	DELIVERY MODE
02/08/2013	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No.	Applicant(s)	
	13/493,207	HULL ET AL.	
	Examiner	Art Unit	
	DARREN W. GORMAN	3752	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11 June 2012*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *8-18* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *8-18* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *07/11/2012*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Information Disclosure Statement

1. The IDS filed on July 11, 2012 is hereby acknowledged and has been placed of record.

Please find attached a signed copy of the IDS.

Claim Rejections - 35 USC § 112

2. The following is a quotation of 35 U.S.C. 112(b):

(B) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims 10, 15 and 16 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Regarding claim 10, the recitation, “wherein the insert member includes three slots” is unclear. Which set of the “at least one radially extending slot” does this claim further limit to including “three slots”? In other words, claim 8 presents “at least one radially extending slot” on a “first end” and “at least one radially extending slot” on a “second end” of the insert member.

Regarding claim 15, the recitation, “the outer sleeve” lacks antecedent basis. What is the “outer sleeve” relative to the “outer shaft” introduced in claim 13?

Regarding claim 16, the recitation, "the inner shaft" lacks antecedent basis.

Double Patenting

4. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

5. Claims 8-12 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-5 of U.S. Patent No. 8,210,453. Although the conflicting claims are not identical, they are not patentably distinct from each other because the aforementioned claims of the patent include each and every structural element of claims 8-12 of the instant application. Claim 8 of the instant application is merely a broader recitation of the device of patented claim 1, in that claim 8 lacks the "third lumen" of patented claim 1.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claims 8-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Reidel et al., USPN 5,605,255, in view of Togashi, US Patent Application Publication No. 2008/0121738.

Reidel shows a spray assembly (see Figures 1-5) for dispensing a mixture, comprising: a connector (see Figure 1) configured for operable engagement with a first and second source of component (A); an elongated member (KZV; see Figures 2 and 3) operably connected to and extending distally from the connector, the elongated member including at least a first lumen (ZK1; see Figures 2 and 3) configured for fluid communication with the first source of

component and a second lumen (ZK2; see Figures 2 and 3) configured for fluid communication with the second source of component; a tip (Z; see Figure 1) operably connected to the connector, the tip including an opening (at AB; see Figure 2) and defining a mixing chamber (at VK and VS; see Figure 2) between a distal end of the elongated member and the opening of the tip; and an insert member (E; see Figure 2) configured to be received in the mixing chamber, the insert member including a plurality of radially extending slots (QK/QKZ; see Figures 4 and 5) at a first end of the insert, wherein the radially extending slots are configured to mix the first and second source of components prior to the combination exiting the opening in the tip. Reidel also shows the assembly including a first and second source of component (A; see again, Figure 1). Reidel further shows the radially extending slots including at least three thereof (see Figure 5).

However, the insert member of Reidel does not have the slots formed on the first end of the insert, but rather the slots are formed on an end wall of the mixing chamber immediately adjacent the first end of the insert member. Further, the device of Reidel is not expressly shown or disclosed to include at least one radially extending slot on the opposite (i.e. second) end of the insert member. It should be noted that the device shown by Reidel is expressly disclosed as being intended for mixing two components and spraying the mixed components as a "fine, uniform mist" (see column 4, lines 4-5), which is due in no small part to the arrangement of the radially extending slots of the mixing chamber.

Togashi shows a spray assembly (see Figures 1-4), including a tip (2) with an insert member (3) located therein, and Togashi discloses radially extending swirl slots located at both an inlet end (at 1e) and at an outlet end (at 2d) of a chamber which houses the insert member, whereby the slots are effective for enhancing a discharge of "fine mist" from the spray assembly

(see paragraph [0013]). Togashi further discloses that forming the slots on either an inlet end of the insert member or on the inlet end wall of the chamber, and forming the slots on either an outlet end of the insert member or on the outlet end wall of the chamber would be functionally equivalent arrangements for affecting the desired effluent fine mist (see paragraph [0063]). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the spray assembly shown by Reidel such that the radially extending slots at the outlet end of the mixing chamber are formed on the first and of the insert member, as taught by Togashi, and such that radially extending slots are also formed on the second end of the insert member, as taught by Togashi, since such an arrangement would effectively enhance the discharge of the desired fine, uniform mist from the opening in the tip, and since the formation of the radially extending slots on either the chamber end walls or on the opposing ends of the insert member would be functionally equivalent arrangements for affecting the desired effluent fine mist from the device.

8. Claims 8-15, 17 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maslanka, DE 295 16 077 U1, in view of Reidel et al. and Togashi.

Maslanka shows a spray assembly (see Figures 1-3) for spraying/dispensing a fine spray mixture of two components, the assembly comprising: a connector (20) configured for operable engagement with a first source of component (24) and a second source of component (26); an elongated member (12) operably connected to and extending distally from the connector, the elongated member including at least a first lumen (14) configured for fluid communication with the first source of component and a second lumen (16) configured for fluid communication with

the second source of component; a tip (28) operably connected to the connector, the tip including an opening (30) and defining a mixing chamber (32) between a distal end of the elongated member and the opening of the tip; and an insert member (46) configured to be received in the mixing chamber, wherein the insert member is configured to enhance mixing of the first and second components prior to the combination exiting the opening in the tip as a fine spray. Maslanka also shows the assembly including a first (at 24) and a second (at 26) source of component. Maslanka further shows the elongated member including an inner shaft (either of the tubes "14" or "16" defining the first and second lumens; see Figure 2) and an outer shaft (the outer shaft portion of "12"; see again, Figure 2). Also, the space between the inner and outer shaft, as applied above, meets the "vent lumen" recitation, absent any specific structural limitations regarding the structure of the claimed device which defines the recited "vent lumen". Further, the outer shaft of the elongated member shown by Maslanka is open at a proximal end thereof (where the shaft connects to the connector "20"), and is open at a distal end thereof (where the shaft connects to the tip "28"). Maslanka also shows the assembly including a transition member (42) operably connecting the elongated member and the tip. Maslanka further shows the insert member including a plurality of spacers (each of the four outside surfaces defined between the grooves "48" of spacer "46") extending longitudinally along substantially the length thereof (see Figures 2 and 3).

However, the insert member shown by Maslanka does not expressly include at least one radially extending slot on a first end of the insert and at least one radially extending slot on a second end of the insert, and thus Maslanka does not expressly include a plurality of radially extending slots on each the first end and the second end of the insert member.

Reidel shows a spray assembly (see Figures 1-5) for dispensing a mixture of first and second components, wherein the spray assembly includes a tip (Z; see Figure 1) connected to an elongated member (KZV; see Figures 2 and 3), which is, in turn, connected to a connector, which is connected to the sources of the first and second components (A), and wherein the tip includes an opening (at AB; see Figure 2) and defines a mixing chamber (at VK and VS; see Figure 2) between a distal end of the elongated member and the opening, and wherein the mixing chamber receives an insert member (E). Reidel also teaches the concept of including a plurality of radially extending slots (QK/QKZ; see Figures 4 and 5) at a first end of the insert, wherein the radially extending slots are configured to mix the first and second components supplied to the mixing chamber prior to being sprayed from the opening in the tip. Reidel also shows the assembly including a first and second source of component (A; see again, Figure 1). Reidel further shows the radially extending slots including at least three thereof (see Figure 5). However, the insert member of Reidel does not have the slots formed on the first end of the insert, but rather the slots are formed on an end wall of the mixing chamber immediately adjacent the first end of the insert member. Further, the device of Reidel is not expressly shown or disclosed to include at least one radially extending slot on the opposite (i.e. second) end of the insert member. It should be noted that the device shown by Reidel is expressly disclosed as being intended for mixing two components and spraying the mixed components as a "fine, uniform mist" (see column 4, lines 4-5), which is due in no small part to the arrangement of the radially extending slots of the mixing chamber.

Togashi shows a spray assembly (see Figures 1-4), including a tip (2) with an insert member (3) located therein, and Togashi discloses radially extending swirl slots located at both

an inlet end (at 1e) and at an outlet end (at 2d) of a chamber which houses the insert member, whereby the slots are effective for enhancing a discharge of "fine mist" from the spray assembly (see paragraph [0013]). Togashi further discloses that forming the slots on either an inlet end of the insert member or on the inlet end wall of the chamber, and forming the slots on either an outlet end of the insert member or on the outlet end wall of the chamber would be functionally equivalent arrangements for affecting the desired effluent fine mist (see paragraph [0063]). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the spray assembly shown by Maslanka, to include radially extending slots in the mixing chamber, as taught by Reidel, in order to enhance mixing of the two components and form a fine, uniform mist; and it would further have been obvious to one having ordinary skill in the art at the time the invention was made to form the radially extending slots taught by Reidel on the first and second ends of the insert member of Maslanka, as taught by Togashi, since such an arrangement would effectively further enhance the discharge of the desired fine spray from the opening in the tip, and since the formation of the radially extending slots on either the chamber end walls or on the opposing ends of the insert member would be functionally equivalent arrangements for affecting the desired effluent fine spray from the device.

9. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Maslanka, as modified by Reidel and Togashi and applied above, and further in view of Miyagi et al., USPN 5,740,965.

Maslanka, as modified above by Reidel and Togashi, shows all of the recited limitations set forth in claim 8, however Maslanka does not expressly include a formable member extending substantially the length of the elongated member.

It should first be noted that the elongated member shown by Maslanka exhibits a very small diameter and a substantial length from the connector element to the tip element (see Figure 1), without any type of reinforcement. Thus, one having ordinary skill in the art would expect that the elongated member of Maslanka would be subject to possible damage along the length thereof, should it strike a hard object or be struck by a hard object.

Miyagi shows a spray assembly (see Figures 11-14) for dispensing a mixture of first and second components (16a, 17a), wherein the spray assembly includes a tip (41) connected to an elongated member (see again, Figure 11), which is, in turn, connected to a connector (14), which is connected to the sources of the first and second components. The elongated member of Miyagi is also shown to exhibit a very small diameter and a substantial length from the connector element to the tip element (see again, Figure 11). Miyagi teaches including a formable member (77) extending substantially the length of the elongated member (see Figures 12-14, which show that element "77" exists in both the wider portion in Figure 13 and in the narrower portion in Figure 14), in order to provide reinforcement to the elongated member. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to include a formable member, as taught by Miyagi, within the elongated member shown by Maslanka, thereby providing reinforcement to the elongated member and reducing the chances that damage occurs in the event that the elongated member strikes a hard object or is struck by a hard object.

Conclusion

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to DARREN W. GORMAN whose telephone number is (571)272-4901. The examiner can normally be reached on M-F 7:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Len Tran can be reached on 571-272-1184. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DARREN W GORMAN/
Primary Examiner, Art Unit 3752

EXHIBIT 7

PATENT
Atty. Docket No. H-US-01208 CON (1603-51 CON)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Les Hull	Examiner:	Darren W. Gorman
Serial No.:	13/493,207	Group:	Art Unit: 3752
Filed:	June 11, 2012	Dated:	May 6, 2013
For:	**SPRAY APPLICATOR**		

Filed Via EFS-Web
Confirmation No.: 3152

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT

Dear Sir:

In response to the Non-Final Office Action dated February 8, 2013, please reconsider the application in view of the following amendments and remarks.

AMENDMENTS TO THE CLAIMS begin on page 2 of this paper.

REMARKS begin on page 4 of this paper.

CERTIFICATE OF ELECTRONIC FILING UNDER 37 C.F.R. §1.6(a)(4)

I hereby certify that this correspondence is being transmitted on the date below with the United States Patent and Trademark Office, PO Box 1450, Alexandria, VA 22313-1450, via electronic submission.

Dated: May 6, 2013

Adrienne Fagan

AMENDMENT TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application:

Listing of the claims:

8. (Currently amended) A spray assembly for dispensing a mixture, the assembly comprising:

a connector configured for operable engagement with a first source of component and a second source of component;

an elongated member operably connected to and extending distally from the connector, the elongated member including at least a first lumen configured for fluid communication with the first source of component and a second lumen configured for fluid communication with the second source of component;

a tip operably connected to the connector, the tip including an opening and defining a mixing chamber between a distal end of the elongated member and the opening of the tip; and

an insert member configured to be received in the mixing chamber, the insert member defining ~~including~~ at least one radially extending slot on a first end of the insert member and at least [[a]] one radially extending slot on a second end of the insert member, each of the radially extending slots being configured to mix the first and second components prior to the combination exiting the opening in the tip.

9. (Previously presented) The spray assembly of claim 8, further including a first and a second source of component.

10. (Currently amended) The spray assembly of claim 8, wherein the insert member includes three slots formed on the first end.

11. (Previously presented) The spray assembly of claim 8, wherein the at least one radially extending slot on the first end of the insert includes a plurality of slots.

12. (Previously presented) The spray assembly of claim 8, wherein the at least one radially extending slot on the second end of the insert includes a plurality of slots.

13. (Currently amended) The spray assembly of claim 8, wherein the elongated member includes an inner shaft and an outer sleeve ~~shaft~~.

14. (Currently amended) The spray assembly of claim 13, wherein the elongated member defines a vent lumen between the inner shaft and the outer sleeve ~~shaft~~.

15. (Previously presented) The spray assembly of claim 13, wherein the outer sleeve includes at least one opening in a proximal end thereof and at least one opening in a distal end thereof.

16. (Currently amended) The spray assembly of claim 13 [[~~8~~]], wherein the elongated member includes a formable member extending substantially the length thereof to permit forming of the inner shaft.

17. (Previously presented) The spray assembly of claim 8, further including a transition member operably connecting the elongated member and the tip.

18. (Previously presented) The spray assembly of claim 8, wherein the insert member includes a plurality of spacers extending longitudinally along substantially the length thereof.

19. (New) The spray assembly of claim 8, wherein the insert member further defines an annular recess on each of the first and second ends of the insert member.

20. (New) The spray assembly of claim 19, wherein the at least one radially extending slot in each of the first and second ends is formed between a line tangent to the respective annular recess and a line α degrees counter-clockwise from the tangent line.

21. (New) The spray assembly of claim 20, wherein α is about twenty degrees.

22. (New) The spray assembly of claim 8, wherein a distal end of the elongated body abuts the first end of the insert.

REMARKS

The above-referenced application has been reviewed in light of the Non-Final Office Action dated February 8, 2013. By the present amendment, Applicant has amended Claims 8, 10, 13, and 14 and added new Claims 19-22. It is respectfully submitted that Claims 8-22, are fully supported by the specification, introduce no new matter, and are allowable over the cited art of record. Prompt and favorable reconsideration of these claims is earnestly sought.

A. Rejection Under 35 U.S.C. § 112

Claims 10, 15 and 16 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite. Specifically, the Examiner noted that, in Claim 10, the recitation, "wheein the insert member includes three slots" is unclear. The Examiner also noted that the recitation "the outer sleeve" in Claim 15 lacks antecedent basis. In addition, the Examiner noted that the recitation "the inner shaft" in Claim 16 lacks antecedent basis. By the present Amendment, Claims 10 and 13 are amended to clarify the claims and to provide antecedent basis for Claims 15 and 16. Accordingly, the rejection of Claims 10, 15, and 16 under 35 U.S.C. § 112, second paragraph, has been overcome and should be withdrawn.

B. Double Patenting

Claims 8-12 were rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over Claims 1-5 of U.S. Patent No. 8,210,453. According to the Examiner, "[a]lthough the conflicting claims are not identical, they are not patentably distinct from each other because the aforementioned claims of the patent include each and every structural element of claims 8-12 of the instant application." Applicants respectfully submit that,

upon indication that Claims 8-12 are otherwise allowable, a terminal disclaimer in accordance with 37 C.F.R. § 1.321(c) or 1.321(d) will be filed.

C. Rejections Under 35 U.S.C. § 103

Claims 8-12 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,605,255 to Reidel et al. ("Reidel") in view of U.S. Patent Application Publication No. 2008/0121738 to Togashi ("Togashi").

An obviousness rejection under § 103 "requires a suggestion of ***all limitations in a claim***." Ex Parte Wada and Murphy, Appeal 2007-3733 at 7 (B.P.A.I. Jan. 2008) (quoting CFMT, Inc. v. Yieldup Intern. Corp., 349 F.3d 1333, 1342 (Fed. Cir. 2003); emphasis added). If the references, alone or in combination, are not shown to teach or suggest each and every element of the claim, then the references cannot support a rejection under § 103. See Ex Parte Wada and Murphy at 7-8.

Applicants respectfully submit that Reidel and Togashi, taken alone or in any proper combination, have not been shown to teach or suggest all the limitations of independent Claim 8. In particular, Reidel and Togashi have not been shown to disclose a spray assembly for dispensing a mixture including, *inter alia*, an insert member "including at least one radially extending slot on a first end of the insert and at least one radially extending slot on a second end of the insert, each of the radially extending slots being configured to mix the first and second components prior to the combination exiting the opening in the tip," as recited in independent Claim 8.

As noted by the Examiner,

> "the insert member of Reidel does not have the slots formed on the first end of

> the insert, but rather the slots are formed on an end wall of the mixing chamber immediately adjacent the first end of the insert member. Further, the device of Riedel is not expressly shown or disclosed to include at least one radially extending slot on the opposite (i.e. second) end of the insert member."

According to the Examiner, Togashi discloses that "forming the slots on either an inlet end of the insert member or on the inlet end wall of the chamber, and forming the slots on either an outlet end of the insert member or on the outlet end wall of the chamber would be functionally equivalent arrangements for affecting the desired effluent fine mist (see paragraph [0063])." Despite the Examiner's assertion, the Examiner has not indicated where in Paragraph [0063] Togashi discloses forming slots on a downstream side (second end) of core 3, or that such an arrangement would be functionally equivalent.

Accordingly, Applicants respectfully submit that the Examiner has not met his burden of establishing a *prima facie* case of obviousness, and the rejection of independent Claim 8 under 35 U.S.C. § 103(a) over Reidel in view of Togashi is improper and should be withdrawn.

Since Claims 9-12 depend from independent Claim 8 and each contains all the features of independent Claim 8, for at least the same reasons Claim 8 is patentable over Reidel and Togashi, Claims 9-12 are also patentable over Reidel and Togashi.

Claims 8-15, 17, and 18 were rejected under 35 U.S.C. § 103(a) as being unpatentable over German Patent No. 295 16 077 to Maslanka ("Maslanka") in view of Reidel and Togashi.

According to the Examiner, "Maslanka does not expressly include at least one radially extending slot on a first end of the insert and at least one radially extending slot on a second end of the insert." (Office Action, page 7, lines 19-21). The Examiner relies on Togashi to disclose the deficient features. As discussed above, the Examiner has failed to indicated where in

Paragraph [0063] Togashi discloses forming slots on a downstream side (second end) of core 3, or that such an arrangement would be functionally equivalent.

Accordingly, Applicants respectfully submit that the Examiner has not met his burden of establishing a *prima facie* case of obviousness, and the rejection of independent Claim 8 under 35 U.S.C. § 103(a) over Reidel in view of Togashi is improper and should be withdrawn.

Claim 16 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Maslanka, as modified by Reidel and Togashi and applied above, and further in view of U.S. Patent No. 5,740,965 to Miyagi et al. ("Miyagi"). The Examiner relies on Miyagi to teach "a formable member (77) extending substantially the length of the elongated member." (Page 10, lines 14-15). Miyagi has not been shown to provide any disclosure that, when taken in any proper combination with Reidel and Togashi, discloses the surgical device of independent Claim 8. Since Claim 16 depends from Claim 8, for at least the reasons discussed above with respect to Claim 8, *inter alia*, Applicants also submit that Claim 16 is also patentable over Reidel, Togashi, and Miyagi.

D. New Claims

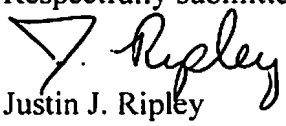
Applicants have added new Claims 19-22. Claims 19-22 depend from independent Claim 8. Applicants submit that Claims 19-22 are also patentable over Reidel, Togashi, Maslanka, and Miyagi for at least the reasons discussed above with respect to Claim 8, respectively.

Conclusion

In view of the foregoing, it is respectfully submitted that all claims presently pending in the application, namely Claims 8-22, are in condition for allowance. Should the Examiner believe that a telephone or personal interview may facilitate resolution of any remaining matters, the Examiner is respectfully requested to contact the representatives for the Applicants at the telephone number indicated below.

Please charge any deficiency as well as any other fee(s) which may become due under 37 C.F.R. §1.16 and/or 1.17 at any time during the pendency of this application, or credit any overpayment of such fee(s) to Deposit Account No. 21-0550. Also, in the event any extensions of time for responding are required for the pending application(s), please treat this paper as a petition to extend the time as required and charge Deposit Account No. 21-0550 therefor.

Respectfully submitted,



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New Haven CT 06511

EXHIBIT 8

pressurized

[**presh**-*uh*-rahyzd]

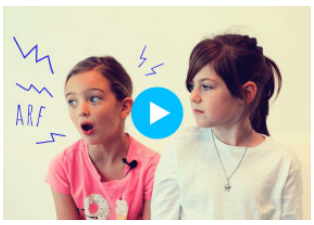
Examples Word Origin

See more synonyms for *pressurized* on Thesaurus.com

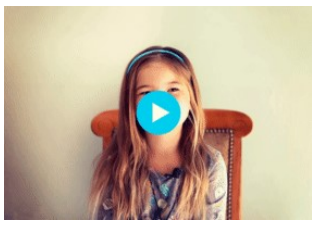
adjective

1. brought to and maintained at an atmospheric pressure higher than that of the surroundings:
   cooking with pressurized steam.
2. maintained at an air pressure comfortable for breathing:
   a pressurized cabin and cockpit; a pressurized suit for diving.
3. *Informal*. subject or subjected to undue pressure or harassment:
   the pressurized milieu of big business.

Explore Dictionary.com



These kids have the


We asked how she would

Origin of pressurized

First recorded in 1935–40; pressurize + -ed[2]

Related forms

un·pres·sur·ized, adjective

pressurize

[**presh**-*uh*-rahyz]

verb (used with object), **pres·sur·ized, pres·sur·iz·ing.**

1. to raise the internal atmospheric pressure of to the required or desired level: *to pressurize an astronaut's spacesuit before a walk in space.*
2. to maintain normal air pressure in (the cockpit or cabin of an airplane) at high altitudes.
3. to apply pressure to (a gas or liquid); supercharge.
4. to pressure-cook.

Also *especially British*, **pres·sur·ise**.

Origin of pressurize

First recorded in 1940–45; pressure + -ize

Related forms

pres·sur·iz·er, noun
re·pres·su·rize, verb, **re·pres·su·rized, re·pres·su·riz·ing.**

Examples from the Web for pressurized

Contemporary Examples

It runs on combustible poison—ammonia and *pressurized* hydrogen.

American Dreams: 'The Mosquito Coast' by Paul Theroux
Nathaniel Rich
September 20, 2012

Historical Examples

Crag debated the problem while they *pressurized* the cabin and removed their suits.

First on the Moon
Jeff Sutton

He nodded to Nagel, snapped his face plate shut and *pressurized* his suit.

First on the Moon
Jeff Sutton

The soft whistle of oxygen escaped from *pressurized* cylinders.

Rich Living
Michael Cathal

The *pressurized* atmosphere gone, the water then is able to pour in through the same opening, flooding the workings.

Smithsonian Institution - United States National Museum - Bulletin 240
Anonymous

Cade, who was in the *pressurized* control room without a suit on, kept working the switch back and forth.

All Day September
Roger Kuykendall

British Dictionary definitions for pressurized

pressurize

pressurise

verb ***(tr)***

1. to increase the pressure in (an enclosure, such as an aircraft cabin) in order to maintain approximately atmospheric pressure when the external pressure is low
2. to increase pressure on (a fluid)
3. to make insistent demands of (someone); coerce

Derived Forms

pressurization *or* **pressurisation**, noun
pressurizer *or* **pressuriser**, noun

Word Origin and History for pressurized

pressurize

v.
1938 (implied in *pressurized*), from pressure (n.) + -ize. Related: *Pressurizing*.

Word of the Day

laeotropic

Real People Write the Dictionary - Meet One of Them

Erase stress and frustration with these words

Nearby words for pressurized

pressure-tube anemometer
pressure-vacuum valve
pressure-volume index
pressurization

pressurize

pressurized

pressurized suit
pressurized-water reactor
presswork
prest
prest money

sleeve

[sleev]

Examples Word Origin

See more synonyms for *sleeve* on Thesaurus.com

noun

1. the part of a garment that covers the arm, varying in form and length but commonly tubular.
2. an envelope, usually of paper, for protecting a phonograph record.
3. *Machinery*. a tubular piece, as of metal, fitting over a rod or the like.

verb (used with object), **sleeved, sleev·ing.**

4. to furnish with sleeves.
5. *Machinery*. to fit with a sleeve; join or fasten by means of a sleeve.

Idioms

6. **have something up one's sleeve**, to have a secret plan, scheme, opinion, or the like:
   I could tell by her sly look that she had something up her sleeve.
7. **laugh up/in one's sleeve**, to be secretly amused or contemptuous; laugh inwardly:
   to laugh up one's sleeve at someone's affectations.

Origin of sleeve

before 950; Middle English *sleve,* Old English *slēfe* (Anglian), *slīefe;* akin to Dutch *sloof* apron

Related forms

sleeve·like, adjective
un·sleeved, adjective

Examples from the Web for sleeve

Contemporary Examples

Borrowing language from his father, Paul said he does not wear his religion "on my *sleeve*."

Is Rand Paul Christian Enough for the GOP?
Olivia Nuzzi
August 2, 2014

Prince Harry has a reputation for wearing his heart on his *sleeve*.

Harry's Heartbreaking Empathy For Orphaned Brazilian Children
Tom Sykes
June 26, 2014

I think with Jason, he really does wear his heart on his *sleeve*.

'True Blood' Star Ryan Kwanten Looks Back on Jason Stackhouse's Craziest Scenes
Kevin Fallon
June 22, 2014

When the gamma rays enter the *sleeve*, they interact with that photon gas, annihilating into electron-positron pairs.

We Can Create Matter from Light?!
Matthew R. Francis
May 20, 2014

On this trip, Rodman put his heart on his *sleeve*—and his foot in his mouth—and said he "loves" Kim.

Ping-Pong Diplomacy Not An Option? Try Ding-Dong Diplomacy
Kevin Bleyer
January 12, 2014

Historical Examples

Well, I know some one who has a *sleeve* with something up it, that's all.

The Spenders
Harry Leon Wilson

Emma finished the *sleeve* of the blouse she was mending with a flourish.

Grace Harlowe's Return to Overton Campus
Jessie Graham Flower

And he turned his head and covered his face with his *sleeve*.

The Underdog
F. Hopkinson Smith

Great beads of sweat stood on his brow and he wiped them away with his *sleeve*.

Howard Pyle's Book of Pirates
Howard Pyle

She was standing by Nicholas, holding the edge of his *sleeve*.

Tiverton Tales
Alice Brown

British Dictionary definitions for sleeve

sleeve

noun

1. the part of a garment covering the arm
2. a tubular piece that is forced or shrunk into a cylindrical bore to reduce the diameter of the bore or to line it with a different material; liner
3. a tube fitted externally over two cylindrical parts in order to join them; bush
4. a flat cardboard or plastic container to protect a gramophone record: US name: **jacket**
5. **roll up one's sleeves** to prepare oneself for work, a fight, etc
6. **up one's sleeve** secretly ready

verb

7. ***(tr)*** to provide with a sleeve or sleeves

Derived Forms

sleeveless, adjective
sleevelike, adjective

Word Origin

Old English *slīf, slēf;* related to Dutch *sloof* apron

Word Origin and History for sleeve

n.
Old English *sliefe* (West Saxon), *slefe* (Mercian) "arm-covering part of a garment," probably literally "that into which the arm slips," from Proto-Germanic **slaubjon* (cf. Middle Low German *sloven* "to dress carelessly," Old High German *sloufen* "to put on or off"). Related to Old English *slefan*, *sliefan* "to slip on (clothes)" and *slupan* "to slip, glide," from PIE root **sleubh-* "to slide, slip."

Cf. slipper, Old English *slefescoh* "slipper," slip (n.) "woman's garment," and expression *to slip into* "to dress in"). Mechanical sense is attested from 1864. To *have something up one's sleeve* is recorded from c.1500 (large sleeves formerly doubled as pockets). Meaning "the English Channel" translates French *La Manche*.

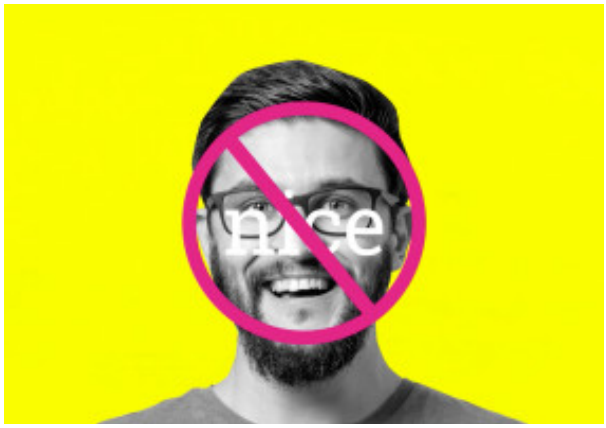
Idioms and Phrases with sleeve

sleeve

see card up one's sleeve; laugh up one's sleeve; roll up one's sleeves; wear one's heart on one's sleeve.

Mifflin Harcourt Publishing Company. Published by Houghton Mifflin Harcourt Publishing Company.

Others Are Reading



This is why being nice isn't so great.

Avoid these words. Seriously

Word of the Day

laeotropic

Real People Write the Dictionary - Meet One of Them

Erase stress and frustration with these words

Nearby words for sleeve

sleepy
sleepy hollow chair
sleepyhead
sleet

sleety

sleeve

sleeve board
sleeve coupling
sleeve dog
sleeve link
sleeve notes